Children's and parents' perceptions of parental support and their effects on children's achievement motivation and achievement in mathematics. A longitudinal predictive mediation model.

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Abstract

Based on Eccles et al.'s expectancy-value model, this study focused on parent- and child-perceived parental support (parental control, warmth and structure) in mathematics, and their effects on mathematics-related achievement motivation (competence beliefs and intrinsic value) and achievement, controlling for previously reported achievement, achievement motivation, intelligence, and gender. Data were analyzed of 457 children and their parents, which had been gathered in the time period from the first to the seventh grade. Structural equation analyses showed that parent-perceived control negatively predicted competence beliefs and achievement in mathematics (the latter mediated by competence beliefs). Parent-perceived warmth had an indirect positive effect on mathematics-related competence beliefs and intrinsic value (mediated by child-perceived warmth) as well as achievement (mediated by both child-perceived warmth and competence beliefs). Parent-perceived structure, mediated by child-perceived structure, positively predicted the intrinsic value of mathematics.

Keywords: parental support, child-perceived, parent-perceived, achievement motivation in mathematics, mathematics achievement

1 Introduction

It is widely recognized that parental support behavior plays an important role for children's motivational and achievement-related development (Pekrun, 2001; Pomerantz, Moorman & Litwack, 2007). Accordingly, the expectancy-value theory of achievement motivation (Eccles (Parsons) et al., 1983; Eccles & Wigfield, 2002) emphasizes the importance of parents' behaviors such as parental support for students' achievement motivation and achievement. The influence of parent-perceived parental support on a child's achievement motivation and – mediated by this – on achievement occurs, at least in part, indirectly, via the child's perception and interpretation of this support (child-perceived parental support; Eccles, 2005; Eccles & Wigfield, 2002; Grolnick, Ryan & Deci, 1991). Parent-perceived *and* child-perceived parental support can therefore be seen as more distal and more proximal antecedents of children's achievement motivation and achievement, respectively.

However, to the best of our knowledge, no previous study has considered these causal relations from a longitudinal perspective. The current study intended to close this research gap. In this respect, we focused on the subject of mathematics, which is a central selection subject when students are allocated to differently tiered secondary schools (at least in the German-speaking area in which the study was conducted).

1.1 Achievement motivation and achievement in mathematics

In the present study, achievement motivation was understood as the internal-psychological "energization and direction of behavior" (Pintrich, 2003, p. 669) relating to a "standard of excellence" (Brunstein & Heckhausen, 2006, p. 143). Eccles and colleagues developed the expectancy-value model of achievement motivation (Eccles (Parsons) et al., 1983; Eccles & Wigfield, 2002) in order to clarify the question of which influencing factors are able to explain individual differences in achievement motivation, in achievement-related

actions, and in achievement. The Eccles et al. model deems *expectancies* and *values* to be important subjective components of students' learning-related achievement motivation. Both expectancies and values are represented in a domain-specific manner (Jacobs, Lanza, Osgood, Eccles & Wigfield, 2002).

Competence beliefs (for overviews of competence-related constructs, see Schunk & Pajares, 2005; Schunk & Zimmermann, 2006; Skinner, 1996) are a central facet of the expectancy component. They reflect the individual's perception of being able to master an achievement-related activity well or successfully (e.g. Eccles & Wigfield, 2002).

Competence beliefs are primarily related to working on tasks in an effortful, resilient manner, and with perseverance (Schunk & Pajares, 2005). Accordingly, the expectancy-value theory of achievement motivation assumes that competence beliefs have a positive effect on achievements (e.g. Eccles (Parsons) et al., 1983; Eccles & Wigfield, 2002). Empirically, it has been shown that competence beliefs in mathematics are positively related to mathematics achievement, even when controlling for prior achievement or intelligence (Buff, Reusser & Pauli, 2010; Marsh, Köller, Trautwein, Lüdtke & Baumert, 2005; Meece, Wigfield & Eccles, 1990; Spinath, Spinath, Harlaar & Plomin, 2006).

The value component is composed of various facets, including the *intrinsic value* of a subject (for an overview of value-related constructs, see Eccles, 2005). Intrinsic value comprises taking pleasure in the achievement-related activity, or the subjective interest in the learning matter or subject to which the activity refers (e.g. Eccles, 2005). It is primarily a predictor of choice behavior, e.g. choice of exercises and courses (e.g. Eccles & Wigfield, 2002). Taylor et al. (2014) emphasize the unique role of intrinsic value with regard to achievement. In their study on the influence of various value-related constructs on achievement, only intrinsic value proved to be a positive predictor, and this was the case even after controlling for prior achievement. As outlined above, however, competence beliefs and

intrinsic value have a differing functional meaning with regard to achievement-related action and achievement: The former are primarily related to the behavior while working on a task itself; the latter is primarily related to the decision whether a task is worked on – and if so, which. Accordingly, the positive effect of intrinsic value on achievement in the subject of mathematics, controlled for prior knowledge or intelligence, can no longer be empirically proven if competence beliefs or related constructs are also considered in the prediction model (e.g. Buff et al., 2010; Marsh et al., 2005; Spinath et al., 2006).

1.2 Parental support and children's achievement motivation and achievement in mathematics

The expectancy-value theory of achievement motivation postulates that contextual characteristics influence children's achievement motivation and achievement (Eccles & Wigfield, 2002). These contextual characteristics can be rather distal (e.g. cultural milieu, socializers' beliefs and behaviors) or rather proximal (e.g. child's perception of socializers' beliefs and behaviors). Thus, an important component is parental support in the sense of parental behavior with respect to their children's learning: Children's achievement motivation and achievement is influenced by how parents behave towards and support their children – and how children perceive this support – in learning situations.

In this study, parental support was understood as "the dedication of resources by the parent to the child within a given domain" (Grolnick & Slowiaczek, 1994, p. 238) such as the child's education, which concerns learning at home in the subject of mathematics. Thus, while parental support is often conceived of in more general terms, the present study addressed a specific subdomain: parental support which first, takes place primarily at home (Pomerantz et al., 2007, pp. 374-375) and second, refers to a specific school subject (Jullien, 2006, pp. 22-24), namely mathematics. Pomerantz et al. (2007) as well as Eccles and colleagues postulate that achievement motivation is of central importance with respect to the

effect of parental support on students' achievements, and that it acts as a mediator of this influence (see also Grolnick et al., 1991). Accordingly, it is pointed out that effects of parental support on achievement should, as far as possible, be examined under consideration of the children's motivation (e.g. Hoover-Dempsey et al., 2001; Patall, Cooper & Robinson, 2008).

The question arises of which characteristics of parental support have a positive or negative effect on achievement motivation and achievement. Eccles and colleagues (Eccles, Arberton, et al., 1993) emphasize that with regard to children's competence beliefs and intrinsic value as well as children's achievement, "the right match of control and structure in a warm and supportive environment with positively motivated role models" (p. 151) seems to be very important. Accordingly, central facets of parental support are addressed, which lead to satisfaction (provision of structure, autonomy support, warmth) or to frustration (lack of structure, control, rejection) of the child's basic psychological needs for competence, autonomy, and relatedness (Connell & Wellborn, 1991; Deci & Ryan, 1985; Skinner, Johnson & Snyder, 2005). The present study focused on three of the aforementioned central dimensions of parental support, which were predominantly developed in the tradition of the self-determination theory (Deci & Ryan, 1985): parental control, parental warmth, and parental structure.

Parental control (e.g. Barber & Harmon, 2001; Grolnick, 2003; Soenens & Vansteenkiste, 2010) is understood as parental behaviors which show "pressure, intrusion, and dominance" (Pomerantz & Grolnick, 2009, p. 166) as common features. Parental control is aimed at influencing children's thoughts, feelings, and/or behavior in the parents' desired direction, without taking into account the children's needs. In particular, parental control impedes or prevents the satisfaction of the need for autonomy, and thereby primarily has a negative impact on intrinsic value (Connell & Wellborn, 1991; Skinner et al., 2005).

Negative effects of parental control are also expected with regard to competence beliefs, as this behavior offers little or no possibility for children to solve learning-related problems themselves (Grolnick & Pomerantz, 2009, p. 169; cf. also Pomerantz, Grolnick & Price, 2005). In line with this, it is assumed that parental control is also negatively related to achievement (Connell & Wellborn, 1991). With regard to the subject of mathematics, the postulated negative relationships of parental control with competence beliefs (Jullien, 2006) and with achievement have been empirically confirmed (e.g. Aunola & Nurmi, 2004; Karbach, Gottschling, Spengler, Hegewald & Spinath, 2013; Silinskas, Kiuru, Aunola, Lerkkanen & Nurmi, 2015)¹.

Parental warmth manifests itself in emotional responsivity as well as in empathetic, appreciative, respectful and loving treatment (e.g. Skinner et al., 2005). It is postulated that parental warmth particularly promotes the satisfaction of children's psychological need for relatedness and has a positive effect on competence beliefs, intrinsic value and achievement (Connell & Wellborn, 1991). To the best of our knowledge, no previous study has examined the effects of parental warmth on achievement motivation in mathematics. With regard to mathematics achievement, the study by Karbach et al. (2013) found no statistically significant effect of a latent factor which besides parental warmth, also comprised parental autonomy support.

Parental structure (e.g. Farkas & Grolnick, 2010) encompasses behaviors such as providing guidance and clear expectations in combination with appropriate limit setting (Grolnick & Pomerantz, 2009; Skinner et al., 2005). It is assumed that parental structure

¹ Karbach et al. (2013) modelled two second-order factors which, besides the children's general cognitive ability and parental education, had an effect on mathematics achievement: a second-order factor with the two first-order factors autonomy and responsivity, and a second-order factor with the two first-order factors control and structure.

particularly promotes the satisfaction of the psychological need for competence, and therefore has a positive impact primarily on competence beliefs, but also on intrinsic value and achievement (Connell & Wellborn, 1991). A study by Grolnick, Raftery-Helmer, Flamm, Marbell & Cardemil (2014) reported a statistically significant positive relationship of parental structure with competence beliefs in mathematics, but not with intrinsic value. In Grolnick et al.'s (2014) study, parental structure proved to be a positive predictor of mathematics achievement, although the effect was not mediated by competence beliefs. Karbach et al. (2013) reported a negative effect of a construct involving both parental control and parental structure on mathematics achievement.

1.3 Parent- versus child-perceived parental support

Analogously to findings from other research areas such as instructional research (see, for instance, Clausen, 2002), which drew on various sources of information (including students and teachers) regarding behaviors or characteristics of parents, relationships between parent-perceived and child-perceived parental support – if both perspectives were assessed – have generally proven to be moderately positive at best (e.g. Gerber & Wild, 2008; Jullien, 2006; Katz, Kaplan & Buzukashvily, 2011; Wild & Remy, 2002).

It is widely argued that with regard to various outcomes on the part of the students, the children's perception and interpretation of parental support is the relevant proximal determining factor (e.g. Barber, Chadwick & Oerter, 1992; Gray & Steinberg, 1999; Jullien, 2006; Morris et al., 2001; Silk, Morris, Kanaya & Steinberg, 2003; Steinberg, Lamborn, Dornbusch & Darling, 1992). The majority of the studies addressing effects of parental support on child-related outcomes accordingly use *one* data source regarding parental support, predominantly students' reports. However, it is increasingly pointed out that parents *and* children should be drawn on as data sources for parental support (e.g. Lorenz & Wild, 2007; Silk et al., 2003; Su, Doerr, Johnson, Shi & Spinath, 2015).

The demand is methodologically justified: With exclusive use of child reports with regard to dependent variables which are also measured via self-report, there is a danger of being unable to distinguish between the shared variance of the same data source (or method variance) and the actual association between two variables (see, for instance, Williams & Steinberg, 2011). However, with reference to Campbell and Fiske (1959) as well as Cronbach (1995), Clausen (2002, p. 57) stresses that, for example, in relation to different perspectives on teaching quality, teachers and their students cannot be considered as independent data sources (and in this respect the “method variance” remains). Nevertheless, he emphasizes that the consideration of different data sources can be of empirical relevance or richness. Su et al. (2015), for instance, showed that solely the parent-perceived control predicted students’ achievement (grades), and not the child-perceived control. They primarily attributed this finding to the high covariance of parent- and child-perceived parental support in their data. Moreover, they pointed out that parents of weaker students may be more likely to show a tendency for intrusive, controlling support behavior.

The expectancy-value theory of achievement motivation (e.g. Eccles (Parsons) et al., 1983; Eccles & Wigfield, 2002) sees parent- and child-perceived parental support as distinct influencing factors (socializers’ behaviors versus the child’s perception of these behaviors) in terms of achievement motivation and achievement. Parent reports on parental support (as a measure of parents’ behavior) constitute more distal contextual influencing factors of achievement motivation and achievement in this regard, while child reports can be seen as rather proximal factors. Eccles and colleagues postulate that the influence of parent-perceived parental support on children’s achievement motivation occurs as an at least partially indirect effect, via the child-perceived parental support. Thus, the hypothesis is formulated that parent- *and* child-perceived parental support should be captured separately and considered sequentially in the effect model – first the parent reports and then the child reports.

1.4 The present study

In the past few years, it has been repeatedly confirmed that parental support is relevant for children's achievement motivation and achievement. However, although the effect of parent-perceived parental support on achievement motivation and achievement, mediated by the child's perception, has been postulated, it has not yet been tested. In particular, studies are lacking which consider several different dimensions of parental support in order to examine the postulated effects of parental support on achievement motivation and – mediated by this – on achievement in mathematics.

In the present study, children's grades in mathematics served as indicators of mathematics achievement. Regarding achievement motivation in mathematics, competence beliefs (e.g. Schunk & Pajares, 2005) and intrinsic value (e.g. Eccles, 2005) were considered. With respect to parental control, the focus was on intrusive parental support. This facet of parental control manifests itself in interference or in unsolicited support (e.g. Grolnick & Pomerantz, 2009; Skinner et al., 2005). Parental warmth referred to empathetic, appreciative, respectful and loving treatment (e.g. Skinner et al., 2005). Finally, as the clarity and consistency of parents' learning-related expectations were central to the present study, we focused on a specific facet of parental structure (Farkas & Grolnick, 2010).

The following question was central to the present study:

How do parent- and child-perceived control, warmth and structure influence six graders' achievement motivation and achievement in mathematics?

Based on the presented theoretical foundations and the empirical findings on the relationships between parental support, achievement motivation and achievement in mathematics, the following hypotheses were tested:

I. Parent-perceived and child-perceived parental support in mathematics:

It was assumed that parent-perceived parental support positively predicts child-perceived parental support: Positive effects of parent-perceived control on child-perceived control, of parent-perceived warmth on child-perceived warmth, and of parent-perceived structure on child-perceived structure were hypothesized.

II. Parental support and achievement motivation in mathematics:

It was hypothesized that parental control negatively predicts achievement motivation. Regarding parental warmth and parental structure, positive effects on achievement motivation were assumed. It was expected that the effects of parent-perceived parental support on competence beliefs and intrinsic value would be at least partially mediated by the children's perception of the parental support.

III. Achievement motivation and achievement in mathematics:

It was postulated that competence beliefs positively predict achievement, whereas the intrinsic value – if both facets of achievement motivation are considered simultaneously – has no statistically significant effect on achievement.

IV. Parental support and achievement in mathematics:

It was assumed that parental control negatively predicts achievement, whereas parental warmth and parental structure positively predict achievement. It was hypothesized that the effects of parent-perceived parental support on achievement occur, at least in part, indirectly, mediated both by the children's perceptions of this support (see hypothesis II) and by the children's competence beliefs (see hypothesis III). It was also assumed that the

intrinsic value does not serve as mediating variable of the influence of parental support on achievement (see hypothesis III).

The postulated effects were tested controlling for prior achievement and prior achievement motivation in mathematics. In terms of the dependent variable achievement in mathematics, intelligence was considered as a further control variable (e.g. Spinath et al., 2006). As gender differences arise in the subject of mathematics, in terms of mean differences particularly in competence beliefs (e.g. Eccles, Wigfield, Harold & Blumenfeld, 1993; Fredricks & Eccles, 2002; Frenzel, Pekrun & Goetz, 2007; Jacobs et al., 2002; Marsh & Yeung, 1998; Watt, 2004; Watt et al., 2012) and intrinsic value (e.g. Gaspard et al., 2015; Watt, 2004; Watt et al., 2012), gender acted as a further control variable.

2 Method

2.1 Participants and sampling procedure

Data were analyzed of 238 girls (52.1%) and 219 boys as well as their parents, who were participating in the TRANSITION study (Buff & Reusser, 2008) funded by the Swiss National Science Foundation (SNF). The students consisted of a subsample of the State of Learning Surveys in the Canton of Zurich, Switzerland (Moser & Hollenweger, 2008; Moser, Hollenweger & Buff, 2011; Moser, Stamm & Hollenweger, 2005), which was conducted on behalf of the Department of Education of the Canton of Zurich. The data were gathered in the time period from the first until the seventh grade. At the first round of data collection, the children were on average 7 years old (6 to 8 years), and in the final round they were approximately 13 years old (12 to 14 years). 399 parents (87.3 %) had German as their first language, while 58 parents (12.7 %) indicated having a different language as their first language. Compared to the general population of sixth graders in the Canton of Zurich, in our

sample, lower social strata were underrepresented and higher social strata were overrepresented.

In the framework of the State of Learning Surveys in the Canton of Zurich, a representative sample was drawn of over 2000 students and their teachers, whose participation was ensured by a letter from the Department of Education (Moser, 2005). The present study used data which were gathered in the first, third and sixth grade.

The initial sample for the sampling procedure of the TRANSITION study comprised those participants who had taken part in the State of Learning Surveys in the Canton of Zurich in the first and the third school year (approx. 1,700 students). The recruitment letters, addressed to the parents, were distributed in the school classes of those school principals and authorities who had granted the necessary permission (approx. 1,000 students). Almost half ($N = 490$) of the parent-child dyads for whom permission to be surveyed was in place agreed to take part in the longitudinal study (first round of data collection at the beginning of the sixth grade). For the present study, data were used which were gathered in the middle of the sixth grade and at the beginning of the seventh grade.

2.2 Data collection and measures

2.2.1 Achievement in mathematics

Achievement in mathematics was measured after the end of the third and sixth school year. The grades in mathematics were used as the measure of achievement. The children's teachers were asked to provide the grades at the end of the third grade (t_3). The grade in mathematics at the end of the sixth grade was gathered retrospectively through a written survey of the students at the beginning of the seventh grade (t_7 ; on the appropriateness of this research-economical practice, see e.g. Kuncel, Credé & Thomas, 2005). The grade scale ranged from 1 to 6, with higher values corresponding to better achievement in mathematics.

2.2.2 Achievement motivation in mathematics: competence beliefs and intrinsic value

Achievement motivation was measured at time point t2 (before the end of the third grade) and t6 (before the end of the sixth grade) in the framework of the State of Learning Surveys of the Canton of Zurich (Moser & Hollenweger, 2008; Moser et al., 2011) by means of questionnaires administered in the children's school classes. A 4-point response format was used for the items: (4) strongly agree, (3) somewhat agree, (2) somewhat disagree, (1) strongly disagree. The children's *competence beliefs* in the subject of mathematics were measured, in line with Buff et al. (2007), by means of six items (e.g. "I am good at mathematics"). The internal consistency of the scale for both measurement time points was good, with Cronbach's alphas of .88 (t2) and .90 (t6), respectively. The *intrinsic value of mathematics* was measured, in line with Buff (2005), by means of four items (e.g. "I enjoy mathematics"). The internal consistency of the scale for both measurement time points was excellent, with Cronbach's alphas of .91 (t2) and .92 (t6), respectively.

2.2.3 Parental support

Parental support in mathematics was measured through questionnaires. The questionnaire was sent by post in the middle of the sixth grade, first to the parents (t4). Once the parents of a parent-child dyad had returned the questionnaire, the child's questionnaire was sent out (t5). Parents and their children rated items tapping into the three parenting dimensions parental control, parental warmth, and parental structure. The items had a parallel wording in the parent and child versions of the questionnaire. Parents of girls were asked about parental support regarding their daughter, and parents of boys regarding their son. When both parents participated, they provided joint responses. These items also had a 4-point response format – '(4) strongly agree to '(1) strongly disagree' (cf. section 2.2.2).

Parental control was operationalized in line with Niggli, Villiger, Wandeler, Kutzelnann and Leopold (2007) as well as Pekrun et al. (2003) by means of three items (e.g. "In mathematics, I sit with my daughter and tell her how to do it" or "In mathematics, my parents sit with me and tell me how to do it"). Cronbach's alphas for the parent-perceived and child-perceived control scales were acceptable, with alphas of .74 (parents, t4) and .72 (children, t5).

Parental warmth was also measured in line with Niggli et al. (2007) and Pekrun et al. (2003) by means of three items (e.g. "I comfort my daughter if she fails in mathematics" or "My parents comfort me if I fail in mathematics"). Cronbach's alphas for the parent-perceived and child-perceived warmth scales were good, with alphas of .78 (parents, t4) and .85 (children, t5).

Parental structure was operationalized in line with Wild et al. (2005a, 2005b) by means of four items (e.g. "My daughter knows how much effort I expect from her in mathematics" or "I know how much effort my parents expect from me in mathematics"). Cronbach's alphas for the parent-perceived and child-perceived structure scales were acceptable, with alphas of .76 (parents, t4) and .72 (children, t5).

2.2.4 Control variables

In addition to achievement motivation (t2) and achievement (t3) in mathematics at the end of the third grade, gender and intelligence were considered in the analyses as control variables. *Gender* was binary-coded (0: girls, 1: boys). Nonverbal *intelligence* was measured at t1 (start of first grade) by trained test administrators in the children's school classes using a German version of the "Culture Fair Intelligence Test" (CFT 1, Weiss & Osterland, 1997; see Moser, 2005).

2.3 Data Analyses

The analyses were conducted using IBM SPSS 22 and *Mplus* 7.31 (Muthén & Muthén, 2012). The hypotheses were examined using a longitudinal, predictive structural equation model. As the accurate normal distribution of the indicators was not given in all cases, the maximum likelihood parameter estimates were obtained with the estimator MLR (Muthén & Muthén, 2012), which is robust to non-normality. The model evaluation was based on multiple criteria: the model chi-square (χ^2), the root mean square error of approximation (RMSEA) including 90 % confidence intervals of RMSEA (90% CI), as well as the test of close fit (CFit), the comparative fit index (CFI), and the standardized root mean square residual (SRMR). A non-significant χ^2 test, an RMSEA less than or equal to .05, a 90% CI with an upper limit of .08, a CFit greater than or equal to .50, a CFI value greater than or equal to .90, and a small SRMR less than or equal to .08 indicated good fit to the data (Brown, 2006; Browne & Cudeck, 1993; Hu & Bentler, 1999).

In mediation analyses, it cannot be assumed that the mediation effect is normally distributed in the population. Therefore, the postulated indirect effects were estimated by means of the bias-corrected bootstrap method (MacKinnon, Lockwood & Williams, 2004) using 10,000 bootstrap resamples (Geiser, 2012).

2.4 Dealing with missing data

As 1,224 (6.1 %) of the 20,108 data points were missing, a missing value analysis was performed using SPSS 22. Little's (1988) MCAR test proved to be non-significant ($\chi^2 = 2696.587$, $df = 2628$, $p = .172$), which indicated that the missing data were missing (completely) at random (Rubin, 1976). Therefore, the full information maximum likelihood (FIML) method (Arbuckle, 1996; Finkbeiner, 1979) was permitted as a technique for dealing with missing data (Allison, 2003; Enders, 2010; Schafer & Graham, 2002).

3 Results

3.1 Preliminary analyses: Partial metric measurement invariance over time (achievement motivation in mathematics)

As mathematics-related competence beliefs and intrinsic value were each measured twice (t2 and t6), prior to the main analyses, it was tested whether the assumption of at least partial metric measurement variance, including the invariance of freely estimated covariances of indicator residuals over time, can be maintained. Within the scope of tests of invariance, starting from an unrestricted model, invariance restrictions are introduced stepwise. Under consideration of the common fit indices, after every newly introduced equality restriction, a comparative Chi-square model comparison is used to test whether or not the introduced restriction leads to a significant deterioration of the fit value. If the model fit does not significantly deteriorate, it can be assumed that the more restricted model does not depict the data significantly worse than the less restricted model. If, however, the fit value significantly deteriorates, a partial invariance model can be tested (e.g. Byrne, Shavelson & Muthén, 1989), in which particular equality restrictions are dropped. It should be noted here that in this new, partially restricted model, a minimum amount of invariance must be ensured: With regard to partial metric invariance, at least two (Byrne et al., 1989) or the majority (Vandenberg & Lance, 2000) of factor loadings must remain invariant across the two measurement time points.

Table 1 shows the fit values of the tested models. The Chi-square model comparisons are described in the text. As the model estimates were undertaken using MLR Estimator, the comparative model comparisons were conducted on the basis of the scaled Chi-square difference test. In a first step, a configural basic model was tested, which depicted the invariant structure of the measurement model over time (configural invariance, see Horn & McArdle, 1992). In this configural model 1, the number of factors and the pattern of indicator-factor loadings were set to be equal over time. The factor loadings of the marker

items were fixed at 1, and the remaining factor loadings were freely estimated across the two measurement time points. The intercepts of the first indicators of each latent construct were set at zero, and the remaining indicator intercepts as well as the latent mean values were freely estimated. Three indicator residual covariances of the latent factor competence beliefs as well as two indicator residual covariances of the latent factor intrinsic value were freely estimated at both time points.

In a next step, it was tested whether the closeness of the linear relationships between latent factors and their corresponding indicators were invariant across both time points (metric invariance, see Horn & McArdle, 1992). If metric invariance is present, it can be assumed that the measurements have the same meaning and structure across the two measurement time points, which is a prerequisite for modeling autoregressive models. In the complete metric invariance model 2a, the factor loadings of the marker items continued to be set at 1. The remaining corresponding factor loadings were set to be equal over time. The intercepts of the first indicators of each latent construct continued to be set at zero. The remaining indicator intercepts, the latent mean values, and each of the five indicator residual covariances were freely estimated. Model 2a showed good fit values, but proved to be significantly worse than the less restricted configural model 1 ($T = 26.110$, $df = 8$, $p = .001$). The modification indices indicated that the invariance restriction for the factor loading of one indicator of the latent construct intrinsic value should be dropped (recoded item: *Mathematics is boring*). The new, partial metric invariance model 2b showed good fit values. Although it showed a significantly better model fit than the complete metric model 2a ($T = 4.280$, $df = 1$, $p = .039$), this model also proved to be significantly worse than the configural model 1 ($T = 21.312$, $df = 7$, $p = .003$). Therefore, based on the modification indices, in a next step, the factor loading of one indicator of the construct competence beliefs was freely estimated across the two measurement time points (item: *I am good at mathematics*). This less

restricted, partial metric model 2c also showed good fit values and led to an improvement of the model compared to the complete metric model 2a ($T = 10.039$, $df = 2$, $p = .007$). By contrast, it was apparent that this model also showed a significantly worse model fit than the configural model 1 ($T = 14.957$, $df = 6$, $p = .021$). Therefore, based on the modification indices, the factor loading of one further indicator of the latent construct competence beliefs was freely estimated across the two measurement time points (recoded item: *I have problems in mathematics*). This partial metric model 2d had a good model fit. It showed a significantly better model fit than the complete metric model 2a ($T = 16.152$, $df = 3$, $p = .001$). Moreover, it was not significantly worse than the configural model 1 ($T = 8.678$, $df = 5$, $p = .123$). As, in model 2d, three of the four corresponding factor loadings of the latent factor intrinsic value, and four of the six corresponding factor loadings of the latent factor competence beliefs were invariant over time, the assumption of partial metric measurement invariance could be maintained.

As five indicator residual covariances were freely estimated at each measurement time point, in a final step, it was tested whether these correlated error terms were invariant over time (partial metric invariance including invariance of indicator residual covariances, see Byrne, 2012). To this aim, the previous invariance restrictions were kept in the model and each of the five covariances of indicator residuals over time were set to be equal. The partial metric model 3a, with invariant correlations of the error terms, showed good fit values and did not lead to a deterioration of the model fit compared to the less restricted model 2d ($T = 2.399$, $df = 5$, $p = .792$). Thus, in terms of achievement motivation, the assumption of partial metric measurement invariance including the invariance of the indicator residual covariances across both time points could be maintained. This permitted the planned calculation of the structural relationships of the constructs of interest.

3.2 Main analyses

Table 2 shows the Pearson correlations between all latent factors of the model as well as grades in mathematics, intelligence and gender, and their mean values and standard deviations. For the estimation of the coefficients, the longitudinal invariance restrictions regarding achievement motivation were considered in the model. Moreover, in relation to parental support, the indicator residual covariances of items formulated in parallel (parents/children) were freely estimated (see, for instance, Kenny, Cook & Kashy, 2006, pp. 106-108).

The longitudinal predictive structural equation model (see figure 1) was primarily modeled in line with the hypotheses based on the expectancy-value theory of achievement motivation (e.g. Eccles & Wigfield, 2002). As, regarding parental support, effects *within* the three main dimensions of parental control, parental warmth and parental structure were of primary interest, the six paths from parent-perceived to child-perceived support which concerned different dimensions (e.g. parent-perceived structure to child-perceived control) were set at zero. The hypotheses were tested controlling for the influence of prior achievement, prior achievement motivation, nonverbal intelligence and gender. The longitudinal invariance restrictions regarding achievement motivation were also modeled within the main analysis, and the indicator residual covariances of items on parental support formulated in parallel (parents/children) were freely estimated.

The fit of the model was good: $\chi^2 = 1042.787$, $df = 813$, $p < .001$, scaling correction factor for MLR = 1.0344; RMSEA [90 % CI] = .025 [.020, .029], CFI = 1.000; CFI = .972; SRMR = .041. Figure 1 shows the structural equation model with its significant, direct effects (standardized coefficients; tests were 2-tailed). Non-significant effects are not depicted.

In the following, the estimated effects are described. In the case of significant direct effects, the standardized coefficient is indicated; the statistical significance level can be found

in figure 1. Statistically significant indirect effects are described in the text. Non-statistically significant effects are not presented.

3.2.1 Parent-perceived and child-perceived parental support in mathematics

As postulated, parent-perceived parental support proved to be a positive predictor of child-perceived parental support: The more parents indicated that they interfered with their children's learning, the more likely the children were to perceive their parents as controlling (parental control; $\beta = .395$); the more parents judged themselves to be empathetic, the more likely the children were to indicate that their parents were empathetic (parental warmth: $\beta = .348$); the more the parents described themselves as providing structure, the more likely the children were to report that their parents' expectations regarding learning were clear (parental structure: $\beta = .428$).

3.2.2 Parental support and achievement motivation in mathematics

3.2.2.1 Effects of parental support on competence beliefs in mathematics

The hypothesis that the effect of parent-perceived parental support on competence beliefs in mathematics is at least partially mediated by child-perceived parental support was only confirmed with regard to parental warmth: Child-perceived parental *warmth* acted as a direct predictor of competence beliefs ($\beta = .150$). Parent-perceived warmth predicted the competence beliefs indirectly, mediated by the child's perception of this support: $b = 0.056$ (95 % CI [0.015, 0.111]). Parent-perceived *control* also influenced the children's competence beliefs, with this occurring directly: More parent-perceived parental control was accompanied by lower competence beliefs in mathematics ($\beta = -.154$). Contrary to expectation, a direct effect of the child's perception of this support on competence beliefs did not materialize. Accordingly, the indirect effect of parent-perceived control on competence beliefs, mediated by the child's perception, was also not confirmed. In terms of parental *structure*, the

postulated relationships were not confirmed: Neither parent- nor child-perceived structure acted as a predictor of competence beliefs in mathematics.

3.2.2.2 Effects of parental support on intrinsic value of mathematics

With respect to the intrinsic value of mathematics, the postulated hypotheses were confirmed regarding two facets of parental support: parental warmth and parental structure. Child-perceived warmth directly predicted intrinsic value ($\beta = .235$), while parent-perceived warmth brought about an indirect effect, which was mediated by the child's perception of this support: $b = 0.109$ (95 % CI [0.047, 0.197]). The relationships were also confirmed regarding parental structure: Child-perceived structure was a positive predictor of intrinsic value ($\beta = .155$), while the influence of parent-perceived structure on the intrinsic value of mathematics was of an indirect nature: $b = 0.130$ (95 % CI [0.015, 0.286]). By contrast, neither parent-perceived nor child-perceived control proved to be a statistically significant predictor of the intrinsic value of mathematics.

3.2.3 Achievement motivation and achievement in mathematics

It was postulated that mathematics-related competence beliefs, but not intrinsic value, exert a positive influence on mathematics achievement, if both facets of achievement motivation are considered simultaneously. This was confirmed, in line with expectation, with regard to the sixth grade (regarding the third grade see section 3.2.5): As postulated, mathematics-related competence beliefs ($\beta = .436$), but not intrinsic value, acted as a statistically significant predictor of mathematics achievement.

3.2.4 Parental support and achievement in mathematics

In terms of the effects of parent- and child-perceived parental support on achievement in mathematics, it was accordingly confirmed that possible effects were mediated by competence beliefs but not by intrinsic value. Although parental support did not exert a direct influence on achievement in mathematics, three indirect effects proved to be statistically

significant. Parent-perceived control negatively predicted achievement in mathematics mediated by competence beliefs: $b = -0.082$ (95 % CI $[-0.164, -0.013]$). Child-perceived control did not serve as a mediating variable of this indirect effect. Parent-perceived warmth had a positive indirect effect on achievement in mathematics. In this regard, both the child's perception of this support as well as the child's competence beliefs in mathematics served as mediating variables: $b = 0.027$ (95 % CI $[0.006, 0.059]$). Furthermore, the child's perception of his or her parents' empathetic behavior (child-perceived warmth), mediated by competence beliefs, indirectly predicted achievement in mathematics: $b = 0.060$ (95 % CI $[0.013, 0.123]$).

3.2.5 Effects of the control variables

Gender proved to be a significant direct predictor of achievement motivation at the end of the third and at the end of the sixth grade, and of mathematics achievement at the end of the sixth grade: At the end of the third grade, boys reported higher competence beliefs ($\beta = .257$) and intrinsic value ($\beta = .202$) than girls. The same pattern was shown regarding achievement motivation at the end of the sixth grade (competence beliefs: $\beta = .087$; intrinsic value: $\beta = .112$). Gender had no influence on the mathematics grade at the end of the third grade, but at the end of the sixth grade, under consideration of the other effects, girls reported better mathematics grades than boys ($\beta = -.107$). Regarding parental support, none of the six effects of gender proved to be statistically significant.

Nonverbal intelligence positively predicted mathematics-related competence beliefs ($\beta = .177$), but not intrinsic value, at the end of the third grade. At the end of the sixth grade, a significant path to intrinsic value ($\beta = .112$), but not to competence beliefs, was found. Nonverbal intelligence also positively predicted mathematics achievement at the end of the third grade ($\beta = .256$) and at the end of the sixth grade ($\beta = .160$). Furthermore, it negatively predicted child-perceived structure in the mid-sixth grade ($\beta = -.141$).

Competence beliefs at the end of the third grade positively predicted mathematics achievement at the end of the third grade ($\beta = .636$) as well as competence beliefs at the end of the sixth grade ($\beta = .157$). *Intrinsic value* at the end of the third grade negatively predicted mathematics achievement at the end of the third grade ($\beta = -.231$) but positively predicted intrinsic value at the end of the sixth grade ($\beta = .293$).

Grade in mathematics at the end of the third grade negatively predicted parent-perceived control in the mid-sixth grade ($\beta = -.226$), but positively predicted competence beliefs in mathematics ($\beta = .419$) as well as mathematics achievement ($\beta = .322$) at the end of the sixth grade.

4 Discussion

4.1 Summary and implications

The aim of this study was to examine the role of child- and parent-perceived control, warmth and structure for children's achievement motivation and achievement in mathematics, and thus to gain in-depth insights into the learning- and achievement-related everyday lives of students and their parents. The effects of interest were tested under consideration of prior achievement, prior achievement motivation, nonverbal intelligence and gender.

In terms of content, the theoretical assumptions were broadly confirmed: Parent-perceived parental support positively predicted child-perceived parental support. Parental control had a particular impact on competence beliefs and achievement in mathematics, while parental structure was primarily important for intrinsic value. It is noteworthy that based on the present findings, parent-perceived warmth appears to play a central role for both facets of children's achievement motivation as well as achievement in mathematics: Only parental warmth significantly predicted, at the same time, both competence beliefs and intrinsic value, as well as achievement, with all (indirect) effects being of a positive nature. However, the

expected negative path from parental control to intrinsic value, and the expected positive path from parental structure to competence beliefs and achievement were not confirmed. A reason for the lack of significant effects of parental control on intrinsic value and parental structure on competence beliefs might lie in the fact that both parent and child reports on parental support were considered, and controlled for the influence of various further variables such as gender, intelligence and particularly also prior achievement motivation and prior achievement in mathematics. Moreover, the lack of significant effect of parental structure on competence beliefs and achievement might be attributable to the fact that this study simultaneously considered the influence of parental warmth, and the specific effect of parental structure was “controlled” by that of parental warmth. Similarly, in the study by Grolnick et al. (2014), for instance, the effects of parental structure on motivational constructs proved not to be statistically significant when parental autonomy support was included in the model.

Regarding parental warmth and structure, as assumed, child-perceived parental support mediated the influence of parent-perceived parental support on achievement motivation and achievement in mathematics. Furthermore, effects of parental support on mathematics achievement emerged indirectly via competence beliefs in mathematics, but not mediated by intrinsic value: In line with expectation, this facet of achievement motivation, at the end of the sixth grade, did not serve as a predictor of mathematics achievement. First, these findings confirm that competence beliefs and intrinsic value have a differing functional meaning regarding their effects on learning actions and achievement (Eccles (Parsons) et al., 1983; Eccles & Wigfield, 2002). Moreover, with respect to the influence of parental support on achievement motivation and achievement, the results also indicate that as postulated, child-perceived parental support acts as a “filter” regarding the effects of parental support behavior on various outcomes on the part of the children (Eccles (Parsons) et al., 1983; Eccles & Wigfield, 2002; Grolnick et al., 1991; Pomerantz et al., 2007): The children’s

perceptions and interpretations of their parents' learning-related support seem to be crucial with respect to their achievement motivation and achievement. However, the dimension "parental control" occupied a special position. Exclusively parent reports regarding this dimension had an explanatory value in terms of the mathematics-related competence beliefs and achievement, but not the children's perceptions of their parents' behavior. In other words: Regarding effects of parental interference on competence beliefs and achievement in mathematics, the parent reports seem to be of primary relevance, when both perspectives are considered. The specific importance of parent-perceived control for school-relevant outcomes on the part of the students should also be considered in the light of a recently published study by Su et al. (2015), which drew attention to the central role of parent-perceived control for children's grades. It is largely unclear how the finding that child-perceived parental control has no effect on achievement motivation or achievement in mathematics should be interpreted. It may be that the facet of parental control considered in the present study – i.e. intrusive parental support in the sense of unsolicited help (see section 1.4) – is not necessarily perceived as a restriction by younger students. If this is the case, then no negative effects will result regarding achievement motivation and achievement. The direct and indirect negative effects of parent-perceived intrusive support on competence beliefs and achievement could also result from the children gaining the impression that they require more help than their peers or siblings, leading to a deterioration of their competence beliefs and ultimately also their achievement. On the other hand, parent-perceived control showed closer negative bivariate relationships both with competence beliefs and with achievement in mathematics than child-perceived control (cf. Table 2). As, moreover, parent- and child-perceived control were substantially correlated (see also Su et al., 2015), meaning that they "competed" in terms of their effects on achievement motivation and achievement, statistically significant

negative effects of child-perceived control on competence beliefs and achievement in mathematics possibly failed to emerge.

Although the *effects of the control variables* on other endogenous variables were not of primary interest, some selected results are worthy of mention. The higher values for mathematics-related competence beliefs and intrinsic value in the boys confirm the findings of other studies in relation to gender differences (Eccles, Wigfield, et al., 1993; Fredricks & Eccles, 2002; Frenzel et al., 2007; Gaspard et al., 2015; Jacobs et al., 2002; Marsh & Yeung, 1998; Watt, 2004; Watt et al., 2012). Differently to in the sixth grade, in the third grade, intrinsic value of mathematics negatively predicted the mathematics grade at the end of the third grade. In view of the consistently positive bivariate associations of gender, intrinsic value, and mathematics achievement at the end of the third grade (see table 2), we suspect that a suppression effect was present here (MacKinnon, Krull & Lockwood, 2000; Rucker, Preacher, Tormala & Petty, 2011).

The children's intelligence at the beginning of the first grade as well as the children's grades in mathematics at the end of the third grade negatively predicted parental control reported by parents in the middle of the sixth grade. This suggests that parents – when they interfere – take into account their children's preconditions (see also Su et al., 2015). In the former case (influence of nonverbal intelligence), moreover, the concern may be with a type of reactive genome-environment covariance (Plomin, DeFries & Loehlin, 1977): Parents respond to lower cognitive abilities of their children with more unsolicited support and interference. Furthermore, nonverbal intelligence at the beginning of the first grade negatively predicted the children's perception of their parents regarding their provision of structure in the middle of the sixth grade. This effect might be interpreted such that at least with respect to specific facets, children process or evaluate their parents' behavior differently depending on their intelligence. Moreover, it cannot be ruled out that the items used to assess

child-perceived structure were formulated in a more challenging way, or were more cognitively demanding, than those on child-perceived control and warmth: Child-perceived structure referred to the expectations of the parents, or rather the knowledge of the parents' expectations, while with respect to parental control and parental warmth, questions referred to the perception of parents' concrete behaviors.

4.2 Strengths and limitations of the study

A strength of this study lies in the fact that it examined effects of parent- and child-perceived parental support on achievement motivation as well as achievement in mathematics longitudinally, controlling for previously reported achievement, achievement motivation, intelligence and gender. In this regard, by means of self-report, three different sources of information (third-grade teachers, parents and children), as well as objective data (intelligence test) were considered.

Despite the strengths of the study and the fact that on the whole, the results were in line with theory, some limitations should be mentioned.

(a) Originally, the expectancy-value theory of achievement motivation was frequently used to explain why girls are underrepresented in science and mathematics study fields and professions. The Eccles et al. model has since established itself as a “general” motivation model, which no longer focuses exclusively on gender differences (Eccles, 2005), and nowadays, much is known about gender differences, particularly with regard to achievement motivation in mathematics. However, in terms of the possible differences between girls and boys related to the structural relationships shown here, little is known. Nevertheless, in view of the number of parameters to be estimated, the testing of the equivalence of the structural relationships modeled in the present study across gender by means of structural equation models would have required larger sample sizes. For this reason, the children's gender served “merely” as a control variable in this study. Accordingly, it was implicitly (for reasons of

simplicity) assumed that the structural relationships are the same, irrespective of the children's gender. In the light of the limited knowledge regarding the indirect effects of various simultaneously considered dimensions of parent-perceived parental support regarding achievement motivation and achievement – via child-perceived parental support – this assumption appears to be justifiable at this point in time.

(b) Furthermore, in this study, the views of mothers and fathers were not measured separately. Such a distinction would enable us to learn to what extent maternally and paternally perceived parenting behavior (see, for instance, Lowe & Dotterer, 2013) – as well as the children's perception thereof – possibly have differing effects on children's mathematics-related competence beliefs, intrinsic value and achievement.

(c) Although the study took into account the three important dimensions parental control, parental warmth and parental structure, in the literature, further central dimensions of parental support, such as autonomy support, rejection and lack of structure, are discussed and examined, which likewise influence children's achievement motivation and achievement (for an overview, see Skinner et al., 2005).

(d) Furthermore, the expectancy-value theory of achievement motivation is a framework model, which contains various individual and contextual factors which influence achievement motivation, achievement-related choices as well as achievement. In the present study, only a small number of the model's components were considered. It would be interesting to learn to what extent the relationships found here could be replicated if further influencing factors and control variables were taken into account. The inclusion of further variables in the model would also reduce the weakness inherent in almost all field studies of a possible distortion of the results due to unconsidered, relevant third variables (omitted variable bias).

(e) Due to the voluntary nature of participation, the sample was not representative.

(f) Despite the longitudinal nature of the study, the presented relationships cannot, in the stricter sense, be seen as causal "in the sense of inferring causality" (Ullman, 2007, p. 677). As it is difficult to conduct experimental studies with larger samples in this research area, the structural equation model presented here should be cross-validated under consideration of equivalent "counter models" in several independent samples, and where necessary should be subject to a (hypothesis-driven) manipulation (e.g. Mulaik, 2000, cited following Kline, 2011, p. 100).

These limitations notwithstanding, the study provides an in-depth insight into the network of effects of home-based support behaviors in mathematics learning, as well as the children's mathematics-related achievement motivation and achievement. Future research could also address the importance of parental support regarding adolescents' achievement motivation and achievement, taking into account further support systems such as friends (e.g. Bissell-Havran & Loken, 2009) or teachers (e.g. Reeve, Jang, Carrell, Jeon & Barch, 2004; Soenens, Sierens, Vansteenkiste, Dochy & Goossens, 2012).

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Table 1*Longitudinal measurement invariance of achievement motivation*

Model	χ^2	scf	<i>p</i>	df	RMSEA	[90 % CI] of RMSEA	CFit	CFI	SRMR
Model 1	214.700	1.1529	<.001	154	.030	[.019, .039]	1.000	.986	.036
Model 2a	240.660	1.1523	<.001	162	.033	[.024, .041]	1.000	.981	.050
Model 2b	235.238	1.1494	<.001	161	.032	[.023, .041]	1.000	.982	.046
Model 2c	229.127	1.1493	<.001	160	.031	[.021, .040]	1.000	.984	.041
Model 2d	223.245	1.1500	<.001	159	.030	[.020, .039]	1.000	.985	.039
Model 3a	224.768	1.1569	<.001	164	.029	[.019, .038]	1.000	.986	.039

Note. $N = 451$. Full information maximum likelihood (FIML) was chosen as the method for dealing with missing data. Estimator = MLR. scf = scaling correction factor for MLR. 2 correlated error terms within intrinsic value and 3 correlated error terms within competence beliefs were freely estimated. Model 1: configural invariance model; Model 2a: metric invariance model; Model 2a: partial metric invariance model with 1 factor loading on intrinsic value freely estimated over time; Model 2c: partial metric invariance model with 1 factor loading on intrinsic value as well as 1 factor loading on competence beliefs freely estimated over time; Model 2d: partial metric invariance model with 1 factor loading on intrinsic value as well as 2 factor loadings on competence beliefs freely estimated over time; Model 3a: partial metric invariance model 2d with invariant covariances of indicator residuals over time. The test statistics for the scaled Chi-square difference tests are described in the text.

Table 2*Pearson correlations and descriptive statistics*

Variables	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Estimated Pearson correlations between latent constructs, grades in mathematics, intelligence, and gender														
I gm_s_t7	–													
II com_s_t6	.681	–												
III iv_s_t6	.306	.579	–											
IV co_s_t5	–.240	–.234	–.084	–										
V wa_s_t5	.108	.148	.274	.032	–									
VI st_s_t5	–.027	–.014	.237	.070	.248	–								
VII co_p_t4	–.307	–.330	–.122	.427	.078	.072	–							
VIII wa_p_t4	–.015	.009	.121	–.012	.369	.219	–.053	–						
IX st_p_t4	.052	.054	.146	.009	.039	.404	.110	.137	–					
X gm_t_t3	.654	.606	.199	–.188	.042	–.133	–.288	–.008	.069	–				
XI com_s_t2	.399	.429	.233	–.160	.035	.008	–.184	.053	.135	.556	–			
XII iv_s_t2	.113	.241	.379	–.018	.029	.087	–.077	.081	.100	.191	.642	–		
XIII IQ_t1	.409	.281	.034	–.168	–.056	–.142	–.216	–.047	.110	.380	.192	.007	–	
XIV Gender ^a	.069	.223	.198	.051	.029	.022	–.026	–.025	.017	.201	.267	.202	.057	–
Estimated means (<i>M</i>) and standard deviations (<i>SD</i>) of the latent constructs, grades in mathematics, intelligence, and gender														
<i>M</i>	4.85	2.62	2.97	2.09	2.94	3.19	1.82	3.29	3.10	4.94	3.13	3.37	107.71	– ^b
<i>SD</i>	.64	.58	.73	.61	.70	.38	.53	.54	.37	.54	.61	.80	12.76	–

Note. *N* = 457. Full information maximum likelihood (FIML) was chosen as the method for dealing with missing data. Estimator = MLR. Longitudinal measurement invariance restrictions were modeled with respect to the two measurement time points of achievement motivation. In terms of parental support, the indicator residual covariances of items formulated in parallel (parent-children) were freely estimated. The data on achievement motivation and parental support referred to learning mathematics. gm = grade in mathematics; com = competence beliefs; iv = intrinsic value; co = parental control; wa = parental warmth; st = parental structure; IQ = non-verbal intelligence. s = students' reports; p = parents' reports; t = teachers' reports; t1 = start of first grade; t2 = before end of third grade; t3 = end of third grade; t4: mid-sixth

grade (first data collection); t5: mid-sixth grade (second data collection); t6 = before end of sixth grade; t7: end of sixth grade (measured at the beginning of seventh grade). 3 to 6 indicators loaded on each latent factor; response formats consisted of a 4-point Likert scale ranging from (1) strongly disagree to (4) strongly agree.

^aGender: 0 = girl; 1 = boy.

^b52.1 % female.

regular black: $p < .05$; *italic black*: $p < .01$; **bold black**: $p < .001$; regular grey: $p \geq .05$.

Figure 1

Figure 1. Structural equation model of the influence of parent- and child-perceived parental control, warmth and structure on children's achievement motivation and achievement in mathematics under consideration of prior achievement, prior achievement motivation, IQ, and gender. Longitudinal measurement invariance restrictions were modeled with respect to the two measurement time points of achievement motivation. In terms of parental support, the indicator residual covariances of items formulated in parallel (parent-children) were freely estimated. Six paths were set at zero: (1) parent-perceived control to child-perceived warmth, (2) parent-perceived control to child-perceived structure, (3) parent-perceived warmth to child-perceived control, (4) parent-perceived warmth to child-perceived structure, (5) parent-perceived structure to child-perceived control, (6) parent-perceived structure to child-perceived warmth. Only statistically significant effects are depicted (standardized results). For significant indirect effects, see text. The measurement model, residual covariances of the latent constructs measured at the same time and non-significant effects are considered but not shown. Control variables as well as their effects on other variables in the model are depicted in grey.

Figure