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Temperamentally inhibited children are at risk for poorer maths performance: self-concept as mediator

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Abstract

It has repeatedly been found that temperamental inhibition and low academic achievement are associated with each other: children with cautious and wary or shy behaviour are at risk for low academic achievement. Several suggestions about the mechanism behind this association have been made, these highlighting for example, the fewer learning opportunities of cautious and wary children and more negative interaction between teachers and inhibited children. However, the empirical studies about these mechanisms are rare and, thus, they have remained unclear. This study examined whether children's maths-related self-concept of ability acts as a mediator between their temperamental inhibition and maths performance. 156 children (M_{age} 7.25 years) were followed during the first grade of primary school. Children's temperamental inhibition was assessed in the beginning of Grade 1. Their maths performance was tested twice, in the beginning and at the end of Grade 1, and their self-concept of ability was measured at the end of Grade 1. The research question was analysed using structural equation modelling. The results showed that children's self-concept of ability did mediate the association between temperamental inhibition and maths performance at Grade 1: that more inhibited children feel they are less capable and competent in maths than less inhibited children, and this contributes to their poorer maths performance. The findings highlight that it is important for teachers and other practitioners to be aware of this effect of temperamental inhibition on self-concept and put effort on promoting positive views of children's competencies and abilities.

In memoriam. Jari-Erik Nurmi has passed away.

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1 Introduction

It is well established that temperamentally inhibited children (i.e., children with cautious, wary and shy behaviour) are at risk for low academic achievement (Rubin et al. 2009). However, less is known about the mechanisms behind the relation between inhibition and academic performance (Hughes and Coplan 2010). Some suggestions have been made about the importance of students' self-evaluative judgments. For example, temperamental inhibition may affect students' emotional experiences in school (Lund 2008; Pekrun et al. 2002), which may then influence their judgments of their own competencies. This negative self-concept of ability (Crozier 1995; Keogh 1986; Martin 1992; Rubin et al. 2009) is then likely to affect students' school performance. The present study aims to fill the gap in the previous literature by examining whether children's maths-related self-concept of ability mediates the effect of their inhibition with respect to maths skill development during the first year of primary school.

Temperamental inhibition refers to wary and fearful reactions in stressful situations, such as when facing novel people, places, or objects (Feng et al. 2008). Closely related concept is shyness, which means feelings of uneasiness, fear or anxiety as reactions when faced with a novel or unfamiliar social situation (Coplan et al. 2004). These concepts are partly overlapping, the main difference being that while shyness refers to wary and cautious behaviour in social contexts, temperamental inhibition is evident in new situations in general, in both social as well as non-social contexts (Dyson et al. 2011). In the present study both social and non-social contexts were included in the measurement and, therefore, the term temperamental inhibition is used.

Temperamental inhibition has been found to be linked to lower levels of academic performance (e.g. Bulotsky-Shearer et al. 2012), lower literacy skills (e.g. Crozier and Hostettler 2003), and, in an increasing number of recent studies, lower maths skills (e.g. Crozier and Hostettler 2003; Dobbs et al. 2006; Viljaranta et al. 2015). Several explanations have been given for these results. Some scholars have suggested that inhibited students have fewer learning opportunities compared to non-inhibited students. For example, because inhibited students are quiet, do not participate, and take a longer time to start and finish their tasks, teachers might not notice the possible learning-related difficulties of these students (Lund 2008; Thomas and Chess 1977) and thus not provide the necessary support for learning, which then impacts on the children's performance. Inhibited children are also likely to withdraw from learning opportunities, particularly if they feel uncomfortable (Rubin et al. 2002; Saarni et al. 1998).

Other suggestions, in turn, are related to the role of the teacher–student relationship. For example, students' temperamental inhibition is likely to play a significant role in teachers' perceptions of students' other characteristics, such as their cognitive abilities (Hughes and Coplan 2010; Thomas and Chess 1977) and teachability, that is, a student's ability to benefit from teaching in the expected way, as perceived by

the teacher (Mullola et al. 2010). These perceptions can affect teachers' attitudes toward students (for a review, see Martin 1989; Guerin et al. 2003), their expectations concerning students' abilities (Keogh 1994), and even their instructional and pedagogical practices with respect to certain students (Buchanan et al. 1998; Nurmi 2012; Thijs et al. 2006), thus affecting children's learning. However, empirical studies examining these mechanisms are rare. In the study of Viljaranta et al. (2015), teachers' interactional style with children was found to act as a mediator between students' temperamental low task orientation/negative emotionality and maths skill development, but not between temperamental inhibition and maths skill development. This result raises the question of what the mechanism behind the relationship between temperamental inhibition and poorer performance could be.

Some scholars have emphasized the role of students' views of themselves in temperamentally inhibited children's skill development: temperamental inhibition affects students' emotional experiences in school (Lund 2008; Pekrun et al. 2002), which affects their self-evaluative judgments of their own competencies. Such a self-concept of ability (Eccles et al. 1983; Crozier 1995; Keogh 1986; Martin 1992; Rubin et al. 2009) is then likely to impact students' school achievement. However, empirical research on these mechanisms is rare. Consequently, in the present study we aim to broaden the earlier research by addressing the question whether self-concept of maths ability mediates the negative association between child's temperamental inhibition and maths performance (Viljaranta et al. 2015) during the first grade of primary school.

2 Methods

2.1 Participants

The present study is part of the LIGHT study (Aunola et al. 2006–2009), which focused on the role of teachers and parents in children's academic skill development and motivation during the first year of primary school in three medium-sized towns in Finland (for a detailed description of the study sample, see Viljaranta et al. 2015). The sample for the present study comprised 156 children (153 at the first measurement point and 156 at the second measurement point; 79 girls, 77 boys; age at the first measurement point $M = 7.26$ years, $SD = 0.32$ years) in regular classrooms as well as their parents and teachers. Ethical permission for the study was obtained from the ethical committee of the University of Jyväskylä before the data collection. Prior to their participation, all the participating teachers and parents provided informed consent to confirm their/their child's voluntary participation in the study.

The children who participated in the study completed two sets of achievement tests during the first grade of primary school, one in October (Time 1) and the other in April (Time 2). The children's self-concept of ability was assessed during Time 2 in an individual interview. Mothers ($n = 153$), fathers ($n = 118$), and teachers ($n = 153$) were asked to respond to a mailed questionnaire concerning the children's temperament during the fall term (October or November; Time 1). All the

participating fathers and teachers answered questions concerning the children's temperament. Of the 153 mothers, 149 (98%) answered these questions.

2.2 Measures and procedures

2.2.1 Children's temperamental inhibition

Each child's temperamental inhibition was rated separately by his or her teacher and both his or her parents as part of a larger temperament-related questionnaire based on the Temperament Assessment Battery for Children—Revised (TABC—R; Martin and Bridger 1999. For a detailed description of the measure, see Viljaranta et al. 2015; Hirvonen et al. 2013; Mullola et al. 2010). The teachers reported on the children's temperamental inhibition by responding to seven Likert-scale items (e.g., "The student takes a long time to become comfortable in a new situation"), while the mothers and fathers responded to eight items (e.g., "My child is shy with unfamiliar adults"). The Cronbach's alpha reliability for the created mean scores was 0.90 for the teachers, 0.92 for the mothers, and 0.91 for the fathers.

2.2.2 Maths performance

The children's maths performance was measured with two tests:

(a) The Children's Knowledge of Cardinal Numbers and Basic Mathematical Concepts was measured with 11 tasks. In each task, a picture with a set of dots was presented to the child, and the child was asked to draw a specific number of dots in a blank space (e.g., "Draw five dots fewer than there are in this picture"; "Draw four dots more than there are in this picture"). The tasks became progressively more difficult, and there was no time limit. One point was given for each correct answer ($M = 9.30$, $SD = 1.70$ at Time 1 and $M = 10.01$, $SD = 1.50$ at Time 2). This test is part of the Diagnostic Test for Basic Mathematical Concepts (Ikäheimo 1996).

(b) In the Basic Arithmetic Test, the children's skills in basic arithmetic were assessed using a set of addition (e.g., "9 + 3 = __"; "86 + __ = 93") and subtraction (e.g., "11 – 2 = __"; "57 – __ = 48") problems. The test included 20 tasks that were presented on a sheet of paper on which each child wrote his or her answers in pencil. The children were asked to complete as many of the tasks as they could without a time limit. One point was given for each correct answer ($M = 6.13$, $SD = 3.54$ at Time 1 and $M = 10.07$, $SD = 3.62$ at Time 2).

The total scores for the children's maths performance at the two measurement points were created by calculating the sum score of the standardized scores (z scores) for the Knowledge of Cardinal Numbers and the Basic Arithmetic Test scores. The Cronbach's alpha reliability for maths performance was 0.85 at the first measurement point and 0.85 at the second measurement point.

2.2.3 Self-concept of ability

Children's self-concept of ability in regard to maths was measured using a modified version of the scale developed by Wigfield et al. (1997). The scale consisted of three items ("How good are you in maths?" "How good are you in maths compared to other students in your class?" "How difficult is maths for you?"). The children first read the question. They were then shown a set of pictures of five squares of different sizes and asked to point out the picture that best described their feelings about how good they were in maths and how difficult they found it (rating 5, picture of a big square = *very good/very difficult;* rating 1, picture of a small square = *not good at all/very easy*). Before administering the test, the procedure was carefully explained to each child. A sum score for maths-related self-concept was created by calculating the mean of the three items after reversing the third item. The Cronbach's alpha reliability for the scale was 0.66.

2.3 Statistical analyses

The research question was analysed using structural equation modelling. In the tested model, child inhibition consisted of three observed indicators: teacher, mother, and father reports. First, a model was carried out without self-concept of ability as a mediator between temperamental inhibition and later maths performance. This model included paths from latent temperamental inhibition at Time 1 to maths performance at Time 1 and Time 2, as well as a stability path from maths performance at Time 1 to Time 2. Second, a mediation model was carried out, including the direct paths from the children's inhibition to their maths performance at Time 1 and Time 2, as well as the indirect path from inhibition to performance at Time 2 via self-concept of maths ability after controlling for the performance level at Time 1. In this model, the path from the children's maths performance at Time 1 to their self-concept of maths ability was also estimated.

The analyses were performed using the Mplus 7.3 statistical software program (Muthén and Muthén 1998–2016). A maximum likelihood estimation with robust standard errors (MLR) was used at each step of the analyses. The fit of the models was evaluated using four indices: $\chi^2(df)$, Bentler's (1990) comparative fit index (CFI), the Tucker Lewis index (TLI), and the root mean square error of approximation (RMSEA). The following results indicated that the model fitted the data well: nonsignificant χ^2 test value, CFI and TLI values greater than 0.95, and RMSEA lower than 0.06 (Muthén and Muthén 1998–2012). The means, standard deviations, and correlations between the study variables are shown in Table 1.

Table 1 The means (M), standard deviations (SD), and correlations between the study variables

	1	2	3	4	5	6
1. Maths skills T1	1.00					
2. Maths skills T2	0.70***	1.00				
3. Inhibition (teacher)	−0.17*	−0.23**	1.00			
4. Inhibition (mother)	0.03	−0.10	0.35***	1.00		
5. Inhibition (father)	0.11	−0.05	0.28**	0.74***	1.00	
6. Self-concept of ability	0.22**	0.36***	−0.22**	−0.11	−0.10	1.00
M	15.41	20.08	2.59	2.72	2.75	4.13
SD	4.44	4.39	0.85	0.96	0.82	0.70

*$p < .05$; **$p < .01$; ***$p < .001$

3 Results

The results showed, first, that children's temperamental inhibition at the beginning of Grade 1 negatively predicted their subsequent test-measured maths performance at the end of Grade 1 after controlling for their previous level of maths performance at the beginning of Grade 1 (*standardized estimate* = −0.20, $p < 0.05$; see also, Viljaranta et al. 2015). However, after including students' self-concept of maths ability in the model (see Fig. 1), the direct effect of student's temperamental inhibition on their subsequent maths performance was no longer statistically significant (*standardized estimate* = −0.15, $p = 0.10$). Moreover, we

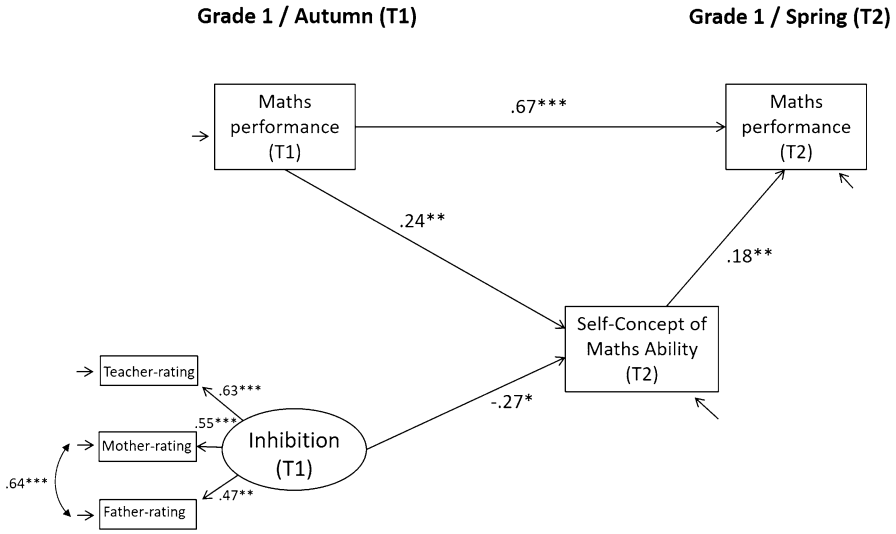

Fig. 1 Students' self-concept of math ability as a mediator between temperamental inhibition and math performance [χ^2 (4) = 4.37, $p = 0.36$; *CFI* = 1.00; *TLI* = 0.99; *RMSEA* = 0.02)]. *Note 1* Only the statistically significant paths are shown in the Figure. *Note 2* ***$p < .001$; **$p < .01$; *$p < .05$. *Note 3* T1 = Time 1, beginning of Grade 1, T2 = Time 2, end of Grade 1

found that the indirect path from students' inhibition to their subsequent maths performance via their self-concept of maths ability was statistically significant (*standardized indirect estimate* = −0.05, $p < 0.05$): the higher the student's level of inhibition, the lower his/her self-concept of maths ability at the end of Grade 1 and, consequently, the lower his/her maths performance, after controlling for the effect of the previous level of maths performance.

4 Discussion

The present study adds to the previous literature on the mechanisms behind the well-known association between temperamental inhibition and poor maths performance. Our results show that more inhibited students at Grade 1 feel that they are less capable and competent in maths than less inhibited students, and this then contributes to their poorer maths performance.

This finding is important in two ways. First, it implies that the suggestion that inhibited students don't receive enough instructions or help in classroom because of their shy and cautious behaviour, which then affects to their poorer skill development (Lund 2008; Thomas and Chess 1977), is not the only mechanism explaining the association between temperamental inhibition and poor academic performance. Our findings suggest that inhibited students really do perceive that they are not able to do maths-related tasks as well as less inhibited students, and this is then reflected in their maths performance. It is possible, for example, that more inhibited students compare themselves to less inhibited students in challenging achievement situations, which can cause feelings of inadequacy (Kristal 2005). Inhibited students have also been found to be more sensitive to the environment (Clauss et al. 2014) and therefore may be more vulnerable to negative experiences (Stright et al. 2008) and more prone to external cues that highlight their failures and inabilities.

Second, this result was found among first-grade students who are just starting their school career. This negative effect of temperamental inhibition on students' self-concept and academic performance at an early stage of schooling is alarming as it is likely to be detrimental to their cumulative skill development. For example, individual differences in maths performance have been shown to increase across school years, with students who show lower performance continuing to perform more poorly across time compared to students showing higher performance (Aunola et al. 2004).

5 Limitations

While the present study shows evidence for the important role of self-concept of ability in temperamentally inhibited students' poorer maths skills, there are some important limitations of the study that need to be taken into account when interpreting the results. First, the sample for the present study was relatively small, and further research with larger samples and in different educational contexts is needed. Second, the reliability of the self-concept measures was relatively poor. One factor

that may have declined the reliability in the present study was the small number of items measuring each construct (see Wells and Wollack 2003). Finally, there were only two measurement points in the study, which limits the possibility of examining the causal relationships between self-concept of ability and maths skills. In addition, the self-concept of ability was measured only once. Studies with more measurement points and longer follow-ups are needed to examine how inhibited students' understanding of their skills actually develops in the classroom over a longer period. By doing that, it would be possible to gain a deeper understanding of the developmental processes between temperamental inhibition, children's self-evaluative judgments, and maths performance.

6 Conclusions

Overall, teachers and other practitioners should be aware of the possibility that temperamentally inhibited children may feel they are less competent in mathematics than children who are less inhibited and this, indeed, may then lead to slower skill development. It would be important to support temperamentally inhibited children not only by concentrating on enhancing their math skills but also promoting positive views of their competencies and abilities. To do that, it is important to be aware of children's individual strengths and needs in order to provide each child optimal challenges with possibilities to succeed and get positive feedback and, via that, possibilities to develop and maintain positive self-concept of ability. Further research is needed to examine the extent to which inhibited students have problems in their interactions with teachers and to what extent are these students especially sensitive to external cues relating to their actual performance level, in order to better understand the mechanisms behind the association between temperamental inhibition and their self-concept and math skills.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

Aunola, K., Leskinen, E., Lerkkanen, M.-K., & Nurmi, J.-E. (2004). Developmental dynamics of math performance from preschool to grade 2. *Journal of Educational Psychology, 96*, 699–713. https://doi.org/10.1037/0022-0663.96.4.699.

Aunola, K., Viljaranta, J., & Nurmi, J.-E. (2006–2009). *Parents, teachers and children's learning (LIGHT)-study*. Jyväskylä, Finland: University of Jyväskylä.

Bentler, P. M. (1990). Comparative fit index in structural models. *Psychological Bulletin, 107*, 238–246. https://doi.org/10.1037/0033-2909.107.2.238.

Buchanan, T. K., Burts, D. C., Bidner, J., White, V. F., & Charlesworth, R. (1998). Predictors of the developmental appropriateness of the beliefs and practices of first, second, and third grade teachers. *Early Childhood Research Quarterly, 13*, 459–483. https://doi.org/10.1016/S0885-2006(99)80052-0.

Bulotsky-Shearer, R. J., Bell, E. R., Romero, S. L., & Carter, T. M. (2012). Preschool interactive peer play mediates problem behavior and learning for low-income children. *Journal of Applied Developmental Psychology, 33*, 53–65. https://doi.org/10.1016/j.appdev.2011.09.003.

Clauss, J. A., Seay, A. L., VanDerKlok, R. M., Avery, S. N., Cao, A., Cowan, R. L., et al. (2014). Structural and functional bases of inhibited temperament. *Social Cognitive and Affective Neuroscience, 9*, 2049–2058. https://doi.org/10.1093/scan/nsu019.

Coplan, R. J., Prakash, K., O'Neil, K., & Armer, M. (2004). Do you 'want' to play? Distinguishing between conflicted-shyness and social disinterest in early childhood. *Developmental Psychology, 40*, 244–258. https://doi.org/10.1037/0012-1649.40.2.244.

Crozier, W. (1995). Shyness and self-esteem in middle childhood. *British Journal of Educational Psychology, 65*, 85–95. https://doi.org/10.1111/j.2044-8279.1995.tb01133.x.

Crozier, W. R., & Hostettler, K. (2003). The influence of shyness on children's test performance. *British Journal of Educational Psychology, 73*, 317–328. https://doi.org/10.1348/000709903322275858.

Dobbs, J., Doctoroff, G. L., Fisher, P. H., & Arnold, D. H. (2006). The association between preschool children's socio-emotional functioning and their mathematical skills. *Journal of Applied Developmental Psychology, 27*, 97–108. https://doi.org/10.1016/j.appdev.2005.12.008.

Dyson, M. W., Klein, D. N., Olino, T. M., Dougherty, L. R., & Durbin, C. E. (2011). Social and non-social behavioral inhibition in preschool-age children: Differential associations with parent reports of temperament and anxiety. *Child Psychiatry and Human Development, 42*, 390–405. https://doi.org/10.1007/s10578-011-0225-6.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., et al. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 75–146). San Francisco, CA: W.H. Freeman.

Feng, X., Shaw, D. S., Kovacs, M., Lane, T., O'Rourke, F. E., & Alarcon, J. H. (2008). Emotion regulation in preschoolers: The roles of behavioral inhibition, maternal affective behavior, and maternal depression. *Journal of Child Psychology and Psychiatry, 49*, 132–141. https://doi.org/10.1111/j.1469-7610.2007.01828.x.

Guerin, D. W., Gottfried, A. W., Oliver, P. H., & Thomas, C. W. (2003). *Temperament: Infancy through adolescence. The Fullerton longitudinal study*. New York, NY: Kluwer Academic/Plenum Publishers.

Hirvonen, R., Aunola, K., Alatupa, S., Viljaranta, J., & Nurmi, J.-E. (2013). The role of temperament in children's affective and behavioral responses in achievement situations. *Learning and Instruction, 27*, 21–30. https://doi.org/10.1016/j.learninstruc.2013.02.005.

Hughes, K., & Coplan, R. J. (2010). Exploring processes linking shyness and academic achievement in childhood. *School Psychology Quarterly, 25*, 213. https://doi.org/10.1037/a0022070.

Ikäheimo, H. (1996). Matematiikan keskeisten käsitteiden diagnostiikka. *[Diagnostic Test for Basic Mathematical Concepts]*. Helsinki, Finland: Opperi.

Keogh, B. K. (1986). Temperament and schooling: Meaning of "goodness of fit"? In J. V. Lerner & R. M. Lerner (Eds.), *Temperament and social interaction in infants and children* (pp. 89–108). San Francisco: Jossey-Bass.

Keogh, B. K. (1994). Temperament and teachers' views of teachability. In W. B. Carey & S. C. McDevitt (Eds.), *Prevention and early intervention: Individual differences as risk factors for the mental health of children* (pp. 246–254). New York: Brunner/Mazel.

Kristal, J. (2005). *The temperament perspective. Working with children's behavioral styles*. Baltimore: Paul H. Brookes Publishing Co.

Lund, I. (2008). 'I just sit there': Shyness as an emotional and behavioural problem in school. *Journal of Research in Special Educational Needs, 8*, 78–87. https://doi.org/10.1111/j.1471-3802.2008.00105.x.

Martin, R. P. (1989). Activity level, distractibility and persistence: Critical characteristics in early schooling. In G. A. Kohnstamm, J. E. Bates, & M. K. Rothbart (Eds.), *Temperament in childhood* (pp. 451–462). West Sussex, England: Wiley.

Martin, R. P. (1992). Child temperament effects on special education: Process and outcomes. *Exceptionality, 3*, 99–115. https://doi.org/10.1080/09362839209524800.

Martin, R. P., & Bridger, R. C. (1999). *The temperament assessment battery for children-revised: A tool for the assessment of temperamental traits and types of young children*. Unpublished manual.

Mullola, S., Ravaja, N., Lipsanen, J., Hirstiö-Snellman, P., Alatupa, S., & Keltikangas-Järvinen, L. (2010). Teacher-perceived temperament and educational competence as predictors of school grades. *Learning and Individual Differences, 20*, 209–214. https://doi.org/10.1016/j.lindif.2010.01.008.

Muthén, L. K., & Muthén, B. O. (1998–2016). *Mplus user's guide*. Los Angeles, CA: Muthén & Muthén.

Nurmi, J.-E. (2012). Students' characteristics and teacher–child relationships in instruction: A meta-analysis. *Educational Research Review, 7*, 177–197. https://doi.org/10.1016/j.edurev.2012.03.001.

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. *Educational Psychologist, 37*, 91–105. https://doi.org/10.1207/S15326985EP3702_4.

Rubin, K. H., Burgess, K. B., & Coplan, R. J. (2002). *Social withdrawal and shyness*. Malden, MA: Blackwell.

Rubin, K. H., Coplan, R. J., & Bowker, J. C. (2009). Social withdrawal in childhood. *Annual Review of Psychology, 60*, 141–171. https://doi.org/10.1146/annurev.psych.60.110707.163642.

Saarni, C., Mumme, D. L., & Campos, J. J. (1998). Emotional development: Action, communication, and understanding. In W. Damon (Series Ed.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology: Vol. 3. Social, emotional, personality development* (pp. 237–309). New York, NY: Wiley.

Stright, A. D., Gallagher, K. C., & Kelley, K. (2008). Infant temperament moderates relations between maternal parenting in early childhood and children's adjustment in first grade. *Child Development, 79*, 186–200. https://doi.org/10.1111/j.1467-8624.2007.01119.x.

Thijs, J. T., Koomen, H. M. Y., & Van Der Leij, A. (2006). Teachers' self-reported pedagogical practices toward socially inhibited, hyperactive, and average children. *Psychology in the Schools, 43*, 635–651. https://doi.org/10.1002/pits.20171.

Thomas, A., & Chess, S. (1977). *Temperament and development*. New York, NY: Brunner/Maze.

Viljaranta, J., Aunola, K., Mullola, S., Virkkala, J., Hirvonen, R., Pakarinen, E., et al. (2015). Children's temperament and academic skill development during the first grade: Teachers' interaction styles as mediators. *Child Development, 86*, 1191–1209. https://doi.org/10.1111/cdev.12379.

Wells, S. C., & Wollack, J. A. (2003). *An instructor's guide to understanding test reliability*. Testing & Evaluation Services publication, University of Wisconsin. https://testing.wisc.edu/Reliability.pdf. Accessed 25 Mar 2020.

Wigfield, A., Harold, R. D., Freedman-Doan, C., Eccles, J. S., Suk Yoon, K., Arbreton, A. J. A., et al. (1997). Change in children's competence beliefs and subjective task values across the elementary school years: A 3-year study. *Journal of Educational Psychology, 89*, 451–469. https://doi.org/10.1037/0022-0663.89.3.451.

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