



LONG-TERM EFFECTS OF SLEEP HABITS AND LEARNING-RELATED BEHAVIORS ON CHILDREN'S FUNCTIONING

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Brief Overview of a Previous Study

“Growth of Cognitive Skills in Preschoolers: Impact of Sleep Habits & Learning-Related Behaviors”

Jung, E., Molfese, V. J., Beswick, J. Jacobi-Vessels, J., & Molnar, A. (2009). Growth of cognitive skills in preschoolers: Impacts of sleep habits and learning-related behaviors. *Early Education and Development*, 20 (4), 713-731.

Overview

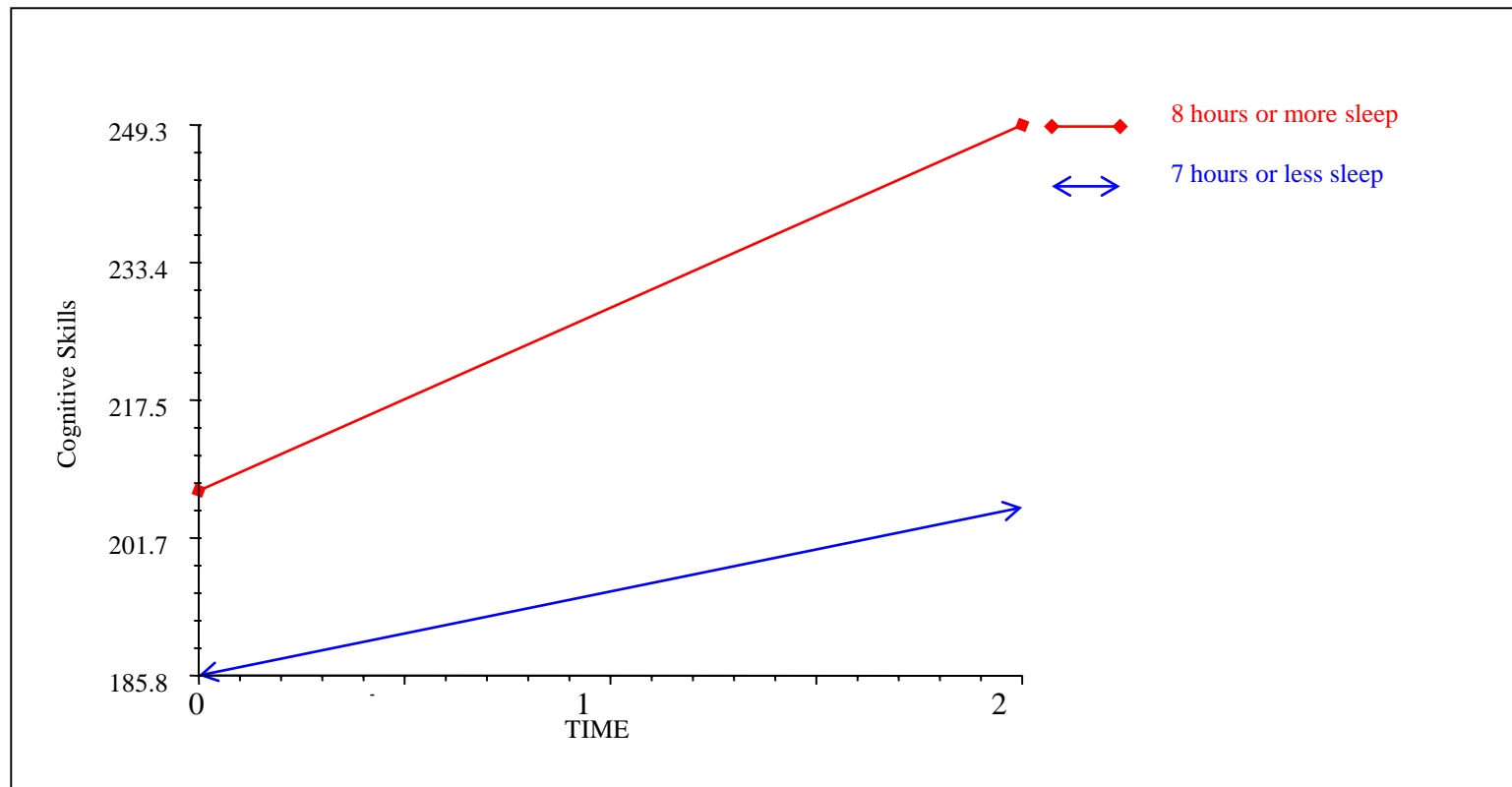


- Using a longitudinal design, impact of sleep habits (hours and sleep problems) and learning-related behaviors on the growth of cognitive skills during the preschool years (ages 3 through 5) was studied.
- Sixty-seven children (37 females and 30 males) with parental report and cognitive skills assessment data
- Using Hierarchical Linear Modeling (HLM: Bryk & Raudenbush, 2002), we estimated growth curves based on standardized scores for the outcome measure.

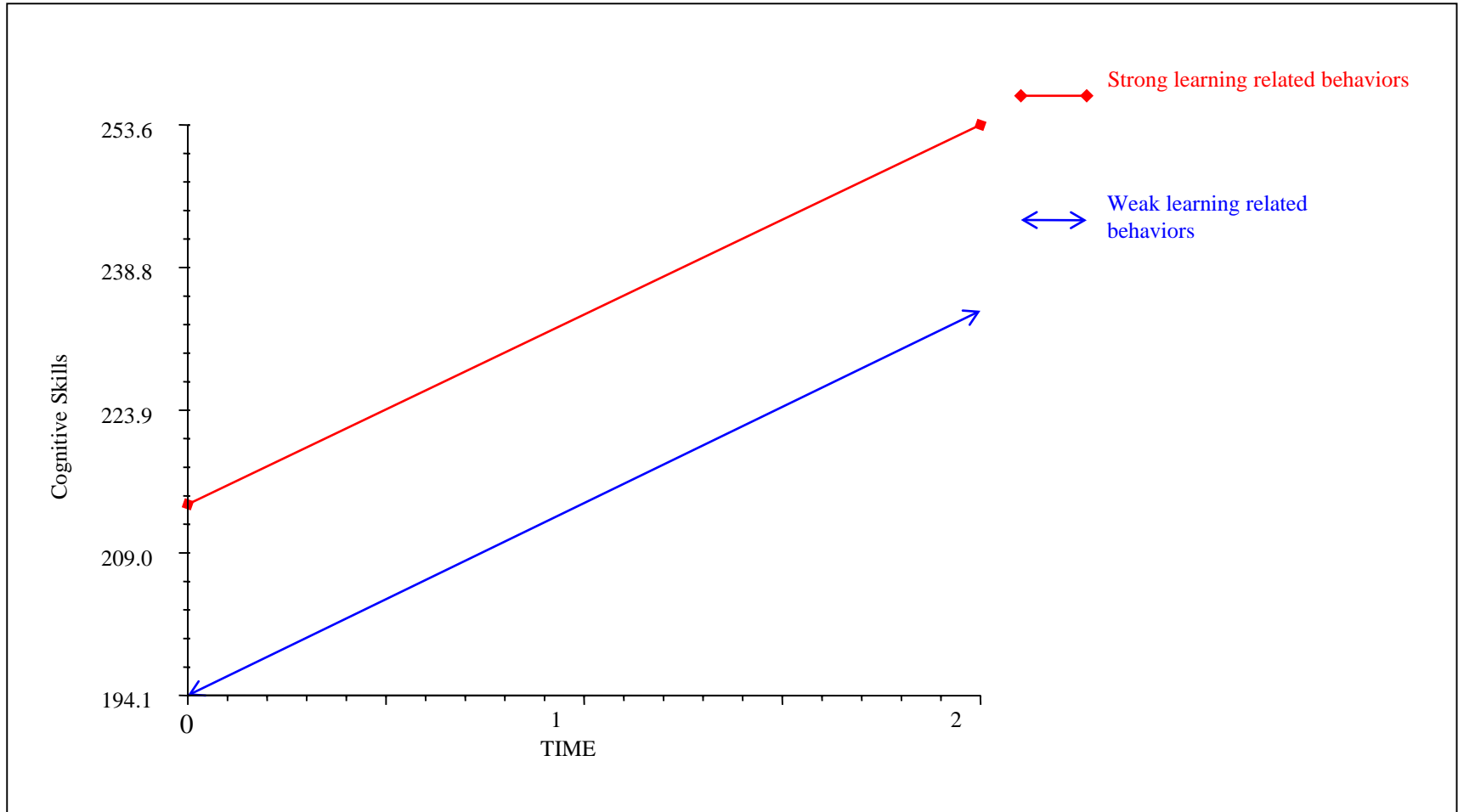
Sleep and learning-related behavior

- On average, children who have over 8 hours sleep and stronger learning related behavior perform better as 3 year olds than do those who have 7 hours or less sleep and weak learning-related behaviors.
- Those who sleep over 8 hours of sleep and strong learning-related behaviors on average increase their cognitive skills constantly over time. At age 5, the GCA (General Conceptual Ability) scores of children who scored high at age 3 were still high.

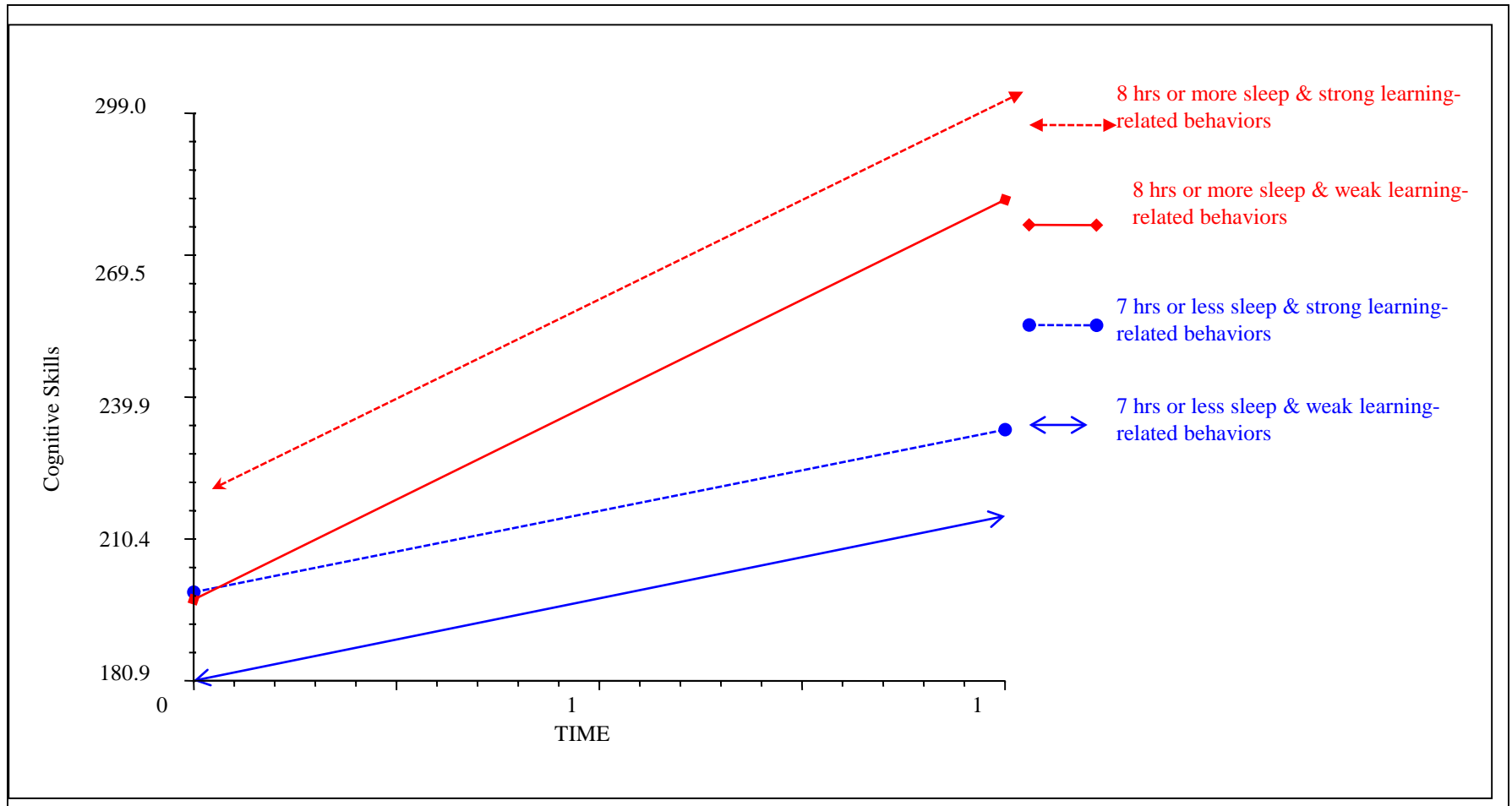
Growth trajectory of cognitive skills as a function of 8 hours or more sleep



Growth trajectory of cognitive skills as a function of learning-related behaviors



Growth trajectory of cognitive skills as a function of hours of sleep and learning-related behaviors



Further study



- Should be expanded beyond the characteristics of the specific sample and duration of this study.
- The relations between sleep habits and children's cognitive skills development warrants an in-depth exploration with a bigger sample.
- Future longitudinal studies should examine children's growth trajectories into elementary school and beyond in relation to sleep habits and behavioral characteristics.

**Direct and Indirect Relationships between Sleep and
Behavior Problems at Age 3 and Cognitive and
Socioemotional Functioning at Age 15:
A Longitudinal Analysis**



Overview



- Using a longitudinal data
- The direct and indirect relationships between sleep and behavior problems at age 3 years and cognitive and socioemotional functioning at age 15 years were examined ($N=1,364$)
- The roles of earlier functioning and developmental processes in later functioning were also investigated.

Rationale



- We do not yet have information about whether the influence of children's early sleep and behavior problems persist into adolescence.
- Investigating the role that early childhood experiences directly and indirectly play in the development of cognitive and socioemotional functioning in adolescence is important for success in school and in life.
- Provide findings that can be shared with parents, educators, and the public.

Guiding Questions



- Can individual differences in the cognitive and socioemotional functioning of adolescents be predicted from sleep and social behaviors in early childhood?
- If so, would such cognitive and socioemotional functioning be influenced by early sleep problems or behavior problems?
- Is the prediction from early childhood experiences to later cognitive and socioemotional outcomes influenced by children's experiences during the first 3 years of life or by developmental experiences?

Research Questions



- (1) To what extent do childhood sleep and behavior problems at age 3 years predict later cognitive skills and socioemotional functioning?
- (2) Are pathways from sleep and behavior problems at age 3 to adolescent functioning mediated through prior functioning?

Data Source

- NICHD Study of Early Child Care and Youth Development (SECCYD)
 - Designed to portray how the transition to adolescence—including cognitive abilities and behavioral adjustment—has changed over time.
 - The sampling and measures used are comparable across the study period.
 - Multiple variables contain the data from each measurement occasion. This provides a more accurate and detailed depiction of American children born in 1991 (who reached age 15 years in 2007)

Data (cont.)

- The SECCYD is a multifaceted study that was conducted on a cohort of children during four phases:
 - from birth through age 3 years (phase 1, 1991–1994)
 - when the children were aged 54 months through 1st grade (phase 2, 1995–1999)
 - grades 2–6 (phase 3, 2000–2004)
 - ages 14–15 years (phase 4, 2005–2007)

Data (cont.)

- Not a nationally representative sample
- Representative of the United States at the time of enrollment.
- A total of 1,364 families constituted the final sample of the SECCYD
- All 1,364 respondents from phases 1 to 4 were included as eligible for this study.
- 659 girls (48.3%), 705 boys(51.7%)
- 1097 White (80.4%), 267 Other races (19.6 %)

Variables



- Child Cognitive Functioning
- Child Socioemotional Functioning
- Child Sleep Problems
- Child Behavior Problems
- Control Variables

Constructs/Demographics	SECCYD Variable Name	Brief Description
Cognitive Functioning Age 15	WJAPWCX5	WJR Applied problems *W Score Age 15
	WJPVWCX5	WJR Picture vocabulary W Score Age 15
	WJVAWCX5	WJR Verbal analogies W Score Age 15
	WJPCWCX5	WJR Passage Comprehension W Score Age 15
Cognitive Functioning Grade 3	WJAPWCG3	WJR Applied problems *W Score 3rd grade
	WJPVWCG3	WJR Picture vocabulary W Score 3rd grade
	WJVAWCG3	WJR Verbal analogies W Score 3rd grade
	WJPCWCG3	WJR Passage comprehension W Score 3 rd grade
Cognitive Functioning Grade 1	WJAPWC1S	WJR Applied problems *W Score 1st grade
	WJPVWC1S	WJR Picture vocabulary W Score 3rd grad
Socioemotional Difficulties Age 15	BAN_TMX5	Anxious/depressed behavior Age 15
	BWT_TMX5	Withdrawn behavior Age 15
	BSO_TMX5	Somatic Complaint behavior Age 15
	BAG_TMX5	Aggressive behavior Age 15
	BTP_TMX5	Thought problem Age 15
	BSP_TMX5	Social problems Age 15
	BAP_TMX5	Attention problems Age 15
	BDB_TMX5	Delinquent behaviors Age 15
Socioemotional Difficulties Grade 3	BTO_TMG3	CBCL Total problem score 3 rd grade
	SSTSSMG3	SSRS Social skills total score 3 rd grade
Socioemotional Difficulties Grade 1	BTO_TM1S	CBCL Total problem score 1st grade
	SSTSSM1S	SSRS Social skills total score 1st grade
Sleep Problems Age 3	PROBPM36	Mother perception of sleep as a problem 36 mo
	NONTSM36	Night waking each night 36 mo
	SLPB1M36	Sleep prob, Zuckerman 36 mo
	SLPB2M36	Sleep problem, Richmond 36 mo
	SLPB3M36	Sleep problem, Lozoff 36 mo
Behavior Problems Age 3	BANXSM36	Anxious/depressed behavior 36 mo
	BWTDSM36	Withdrawn behavior 36 mo
	BSOMSM36	Somatic behavior 36 mo
	BAGRSM36	Aggressive behavior 36 mo
	BDSTSM36	Destructive behavior 36 mo
Demographics	CSEX_M01	Child's gender
	CRACEM01	Child's ethnicity
Family Background/SES	MEDUCM01	Maternal education
	INCNTM36	Total Income to Needs to Ratio 36 mo
Work Commitment	WKCMTM36	Mom work commitment 36 mo
Maternal Stress	PAREXM36	Parenting stress/mom 36 mo

Note: * W score (the raw score or ability level) were used in this analysis. The W scale has mathematical properties (e.g., equal interval units) that make it well suited for the interpretation of test performance. Standard scores were also be used.

Child Cognitive Functioning



- Cognitive Functioning at age 15 years
- Cognitive functioning in grade 1 and grade 3 for the study of the role of developmental processes
- The Woodcock–Johnson Psycho-Educational Battery–Revised (WJ–R; Woodcock & Johnson, 1989)

Socioemotional Functioning

- Socioemotional functioning at age 15 years.
- Socioemotional functioning in grade 1 and grade 3 for the study of the role of developmental processes.
- Social Skills Rating System (SSRS; Gresham & Elliott, 1990)
- Child Behavior Checklist 4–18 y (CBCL/4-18; Achenbach, 1991)
- Withdrawn, somatic, anxious/depressed, social problems, thought problems, attention problems, delinquency, and aggressive behaviors.
- For socioemotional functioning at child grade 1, grade 3, and age 15 years, the total CBCL/4-18 score was loaded onto the latent variable of child socioemotional functioning.

Sleep Problems

- Mother's perception of sleep as a problem
- Night waking each night
- Items on the Sleep Problems Assessed in the Home Interview
- The Home Interview collected specific information from all participating mothers using a systematic form and objective techniques.
- The sleep related questions in the family health section in the Home Interview section were included in this study
- Child age 3

Behavior Problems

- Items on the Child Behavior Checklist-2/3 (CBCL/2-3; Achenbach, 1992)
- Anxious/depressed, withdrawn, somatic, aggressive, destructive
- Child age 3 years

Control Variable

- Selection bias is a concern in nonexperimental studies because family and child characteristics are related to children's functioning
- Child gender
- Child race/ethnicity
- Family total income-to-needs ratio, the maternal education level
- Maternal parenting stress
- Maternal work commitment

Analytic Strategies

- Structural equation modeling (SEM) with maximum likelihood estimation and the bootstrapping method
- Longitudinal data analysis with extended autoregressive mediation model including cross-lagged regression relations
- Missing data were imputed through the maximum likelihood method.
- Factor loadings were estimated through confirmatory factor analysis (CFA) as part of the measurement model for respective longitudinal variables.

Analytic Strategies (cont.)

- Mediation test was conducted for the significant indirect associations between child problems at age 3 years and children's later functioning to find out which variable in the model mediated the indirect associations
- Guided by Baron and Kenny (1986) and Cole and Maxwell (2003)
- The significance testing based on the bootstrapping method (MacKinnon, Fairchild, & Fritz, 2007).

Model Fit

- Chi square (χ^2) test
- Comparative Fit Index (CFI; Bentler, 1990)
- Normed Fit Index (NFI; Bentler & Bonett, 1980)
- Non-Normed Fit Index (NNFI; Marsh, Balla, & McDonald, 1988)
- Root-mean-square error of approximation (RMSEA; Browne & Cudeck, 1993).
- CFI, NFI, and NNFI values over .90 considered an indication of a good model fit
- RMSEA values lower than .06 considered an indication of good fit (Hu & Bentler, 1999; Kaplan, 2000).

Confirmatory Factor Analysis (CFA)

- Maximum likelihood confirmatory factor analysis was conducted to confirm the adequacy of the measurement model for each time-series variable
 - First, the measurement model with **child socioemotional difficulties** at age 3 years, in grade 1, in grade 3, and age 15 years was tested.
 - All subscales were loaded significantly above .5 ($p < .05$) onto the latent variables.
 - The model fit: $\chi^2(106, N = 1364) = 433.20, p < .001, CFI = .974, NFI = .966, NNFI = .967,$ and $RMSEA = .048$ (90% CI .043-.052).
 - All of the correlations between the latent variables were significant, ranging from .52 to .88.

CFA (cont.)

- Maximum likelihood confirmatory factory analysis was conducted to confirm the adequacy of the measurement model for each time-series variable
 - Second, the measurement model for **cognitive functioning** in grade 1 and grade 3 and at age 15 years
 - Factor loadings for all subscales were above .7 ($p < .05$).
 - The model fit: $\chi^2(23, N = 1364) = 84.53, p < .001, CFI = .995, NFI = .993, NNFI = .990,$ and $RMSEA = .044$ (90% CI .034-.055).
 - All of the correlations between latent variables were significant, ranging from .91 to .96.

CFA (cont.)

- Maximum likelihood confirmatory factor analysis was conducted to confirm the adequacy of the measurement model for each time-series variable
 - Third, the measurement model for **child sleep problems** at ages 3 and 15 years was tested
 - The correlation between the two sleep variables at age 3 and 15 years was not significant ($r=.001$, $p=.98$). Variable of sleep problems at age 15 years was not appropriate to be included in the model according to Cole and Maxwell (2003)
 - Sleep problems at age 15 variable has been totally removed from the study.
 - The measurement test with sleep problems at age 3 years solely was estimated
 - All subscales were loaded significantly onto the sleep problem variable above .5 ($p<.05$).
 - The model fit: $\chi^2(2, N = 1364) = 14.18$, $p=.001$, CFI=.995, NFI=.994, NNFI=.973, and RMSEA= .06 (90% CI .037-.101).

Direct Relationships between Early Sleep and Behavior Problems and Later Functioning

- Sleep problems at age 3 are directly related with behavior problems at age 3.
- Sleep problems at age 3 are not related with socioemotional difficulties in grade 1, 3, and age 15
- Sleep problems at age 3 are not related with cognitive functioning in grade 1, 3, and 15.
- Behavior problems at age 3 are directly related with socioemotional difficulties in grade 1.
- Behavior problems at age 3 are directly related with cognitive functioning in grade 1 and 3.
- Sleep problems at age 3 influence behavior problems at age 3 but not vice versa.

Direct Paths (Four-Wave Longitudinal Data)

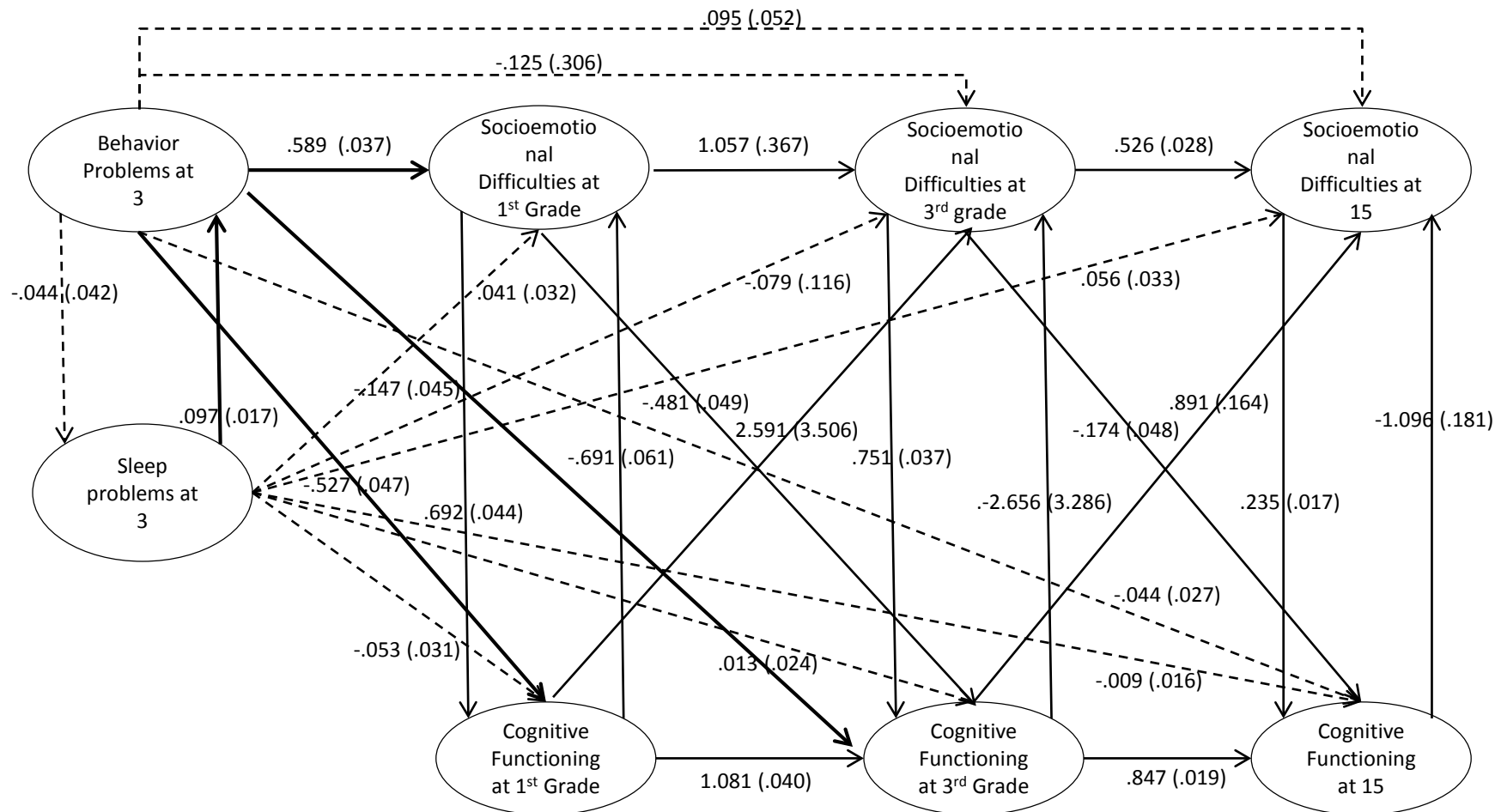


Figure 1. Standardized SEM Maximum Likelihood Estimates from Testing Paths of Sleep Problems and Socioemotional Difficulties at age 3 on Child Socioemotional and Cognitive Trajectories until Age 15 with Four-Wave Longitudinal Data.

Note. Standardized estimates (β) and standardized errors (SE) are shown here. Model fit statistics: (582, N=1364) = 1880.06, $p < .001$, CFI=.956, NFI=.938, NNFI=.947, RMESA=.040 (90% CI .038-.043).

Pathways from Sleep and Behavior Problems at Age 3 to Adolescent Functioning

- There was no significant indirect path from child sleep problems at age 3 years to child cognitive functioning in grade 1, grade 3, and age 15 years.

Indirect Path

- There was a significant indirect path from child sleep problems at age 3 years to child socioemotional difficulties in grade 1 ($\beta=.073$, $p=.002$)
- The association between sleep problems at age 3 and socioemotional difficulties in grade 1 is mediated by behavior problems at age 3.

Indirect Paths

- There was a significant indirect path from child sleep problems at age 3 years to child socioemotional difficulties in grade 1 ($\beta=.073$, $p=.002$)
- The association between sleep problems at age 3 and socioemotional difficulties in grade 1 is mediated by behavior problems at age 3.

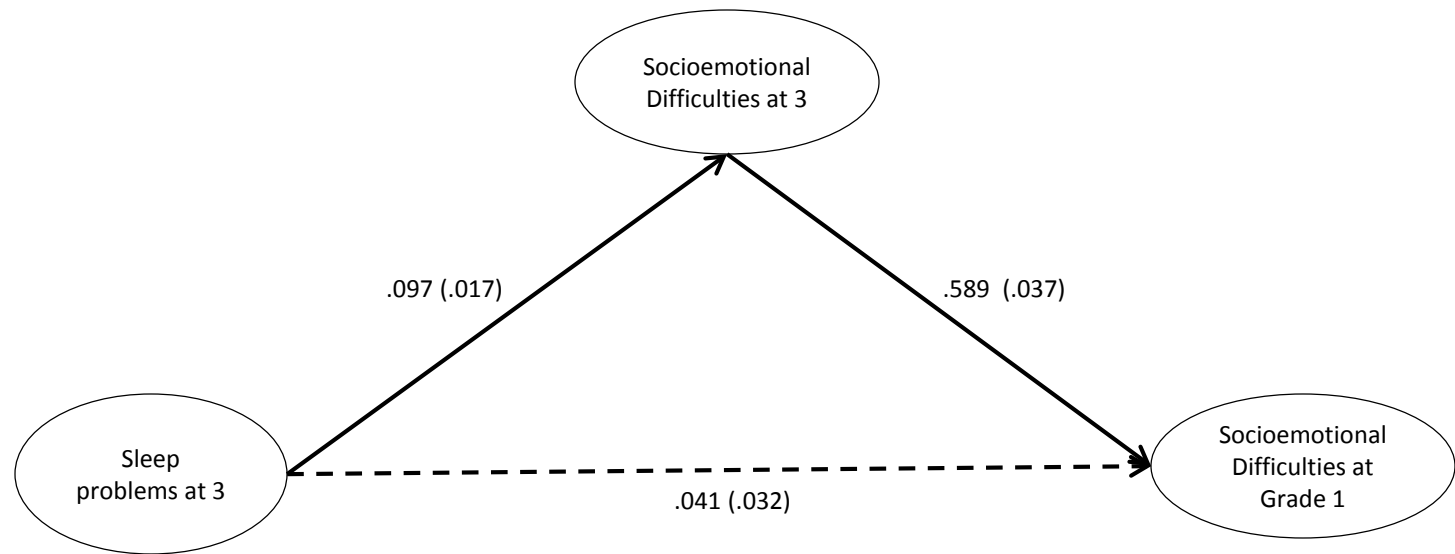


Figure 2. The Mediating Role of Socioemotional Difficulties at 3 Years in an Association between Sleep Problem at 3 Years and Socioemotional Difficulties in Grade 1.

Note: Standardized estimates (β) and standardized errors (SE) are shown here. The lines in the figure are about direct paths between the two variables after accounting for the remaining variables. The total effect between an association between sleep problem at 3 years and socioemotional difficulties in grade 1 was $\beta = .114$, $SE = .028$, $p = .003$ and the indirect effect was $\beta = .073$, $SE = .021$, $p < .01$.

Indirect path



- The significant indirect path between child behavior problems at 3 years and cognitive functioning at 15 years
- Association between behavior problems at age 3 and cognitive functioning at 15 years is mediated by cognitive functioning in grade 3.

Indirect Paths

- The significant indirect path between child behavior problems at 3 years and cognitive functioning at 15 years
- Association between behavior problems at age 3 and cognitive functioning at 15 years is mediated by cognitive functioning in grade 3.

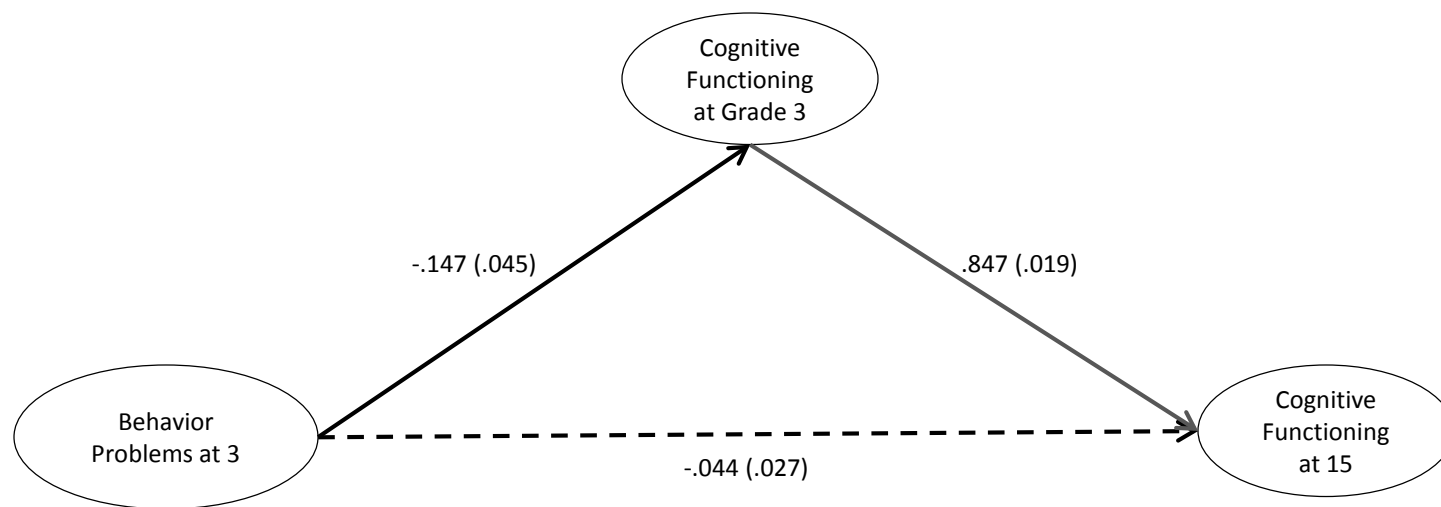


Figure 3. The Mediating Role of Cognitive Functioning in Grade 3 in an Association between Behavior Problems at 3 Years and Cognitive Functioning at 15 Years.

Note: Standardized estimates (β) and standardized errors (SE) are shown here. The lines in the figure are about direct paths between the two variables after accounting for the remaining variables. The total effect between an association between socioemotional difficulties at 3 years and cognitive functioning at 15 years was $\beta = -.119$, $SE = .030$, $p = .004$ and the indirect effect was $\beta = -.147$, $SE = .031$, $p = .126$.

Indirect Path

- There was a significant indirect path from child behavior problems at age 3 years to child socioemotional difficulties in grade 1 ($\beta=.051$, $p=.001$), grade 3 ($\beta=.721$, $p=.003$), and age 15 ($\beta=.359$, $p=.001$).
- The association between behavior problems at age 3 and socioemotional difficulties at grade 3 is mediated by cognitive functioning at grade 1.
- The association between behavior problems at age 3 and socioemotional difficulties at grade 3 is mediated by socioemotional difficulties in grade 1.

Indirect Paths

- There was a significant indirect path from child behavior problems at age 3 years to child socioemotional difficulties in grade 1 ($\beta=.051$, $p=.001$), grade 3 ($\beta=.721$, $p=.003$), and age 15 ($\beta=.359$, $p=.001$).
- The association between behavior problems at age 3 and socioemotional difficulties at grade 3 is mediated by cognitive functioning at grade 1
- The association between behavior problems at age 3 and socioemotional difficulties at grade 3 is mediated by socioemotional difficulties in grade 1.

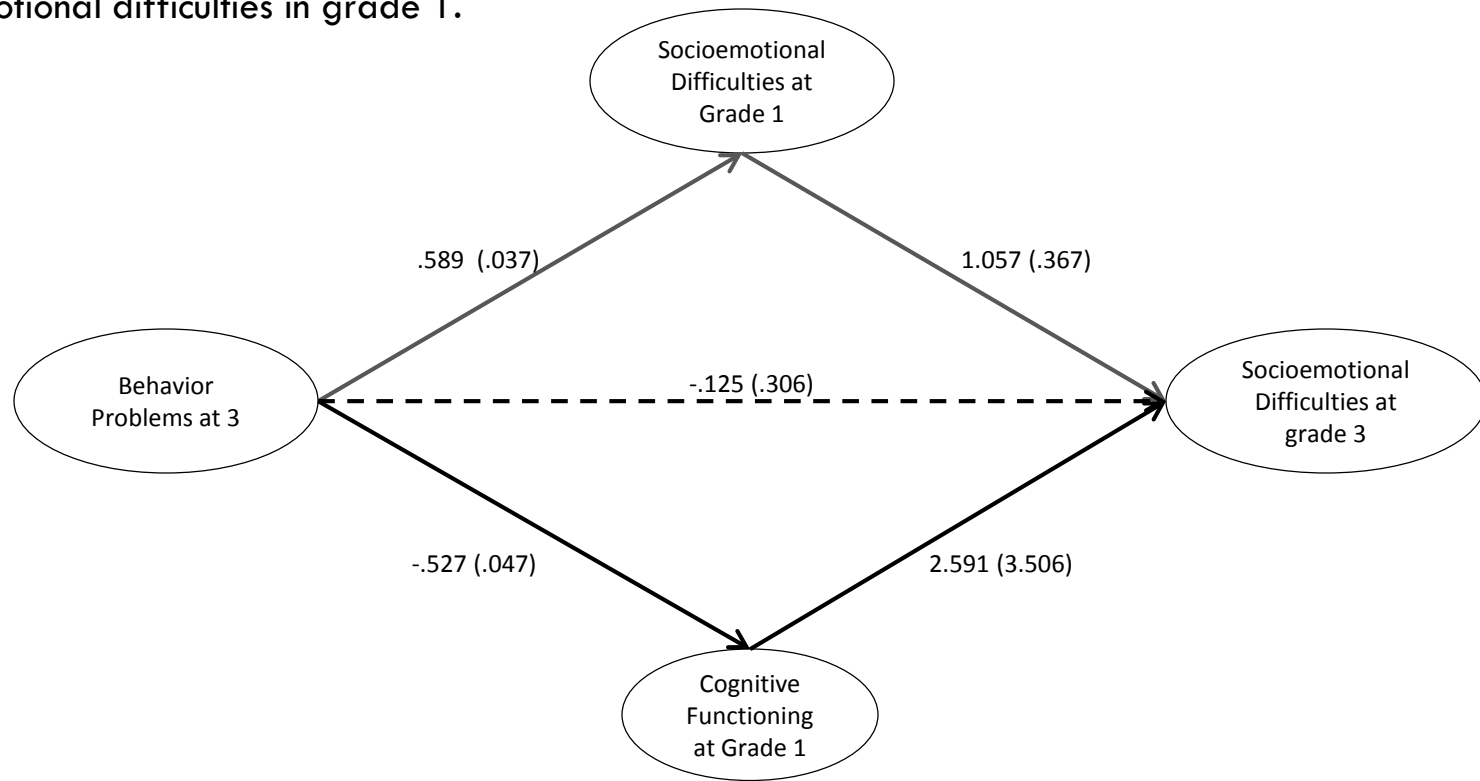


Figure 4. The Mediating Role of Cognitive Functioning and Socioemotional Difficulties at Grade 1 in an Association between behavior problems at 3 Years and Socioemotional Difficulties at Grade 3

Note: Standardized estimates (β) and standardized errors (SE) are shown here. The lines in the figure are about direct paths between the two variables after accounting for the remaining variables. The total effect between an association between socioemotional difficulties at 3 years and socioemotional difficulties at grade 3 was $\beta=.597$, $SE=.030$, $p=.001$ and the indirect effect was $\beta=.721$, $SE=.305$, $p=.003$.

Indirect Path



- The association between behavior problems at age 3 and socioemotional difficulties at 15 years is mediated by cognitive functioning in grade 3.

Indirect Path

- The association between behavior problems at age 3 and socioemotional difficulties at 15 years is mediated by cognitive functioning in grade 3.

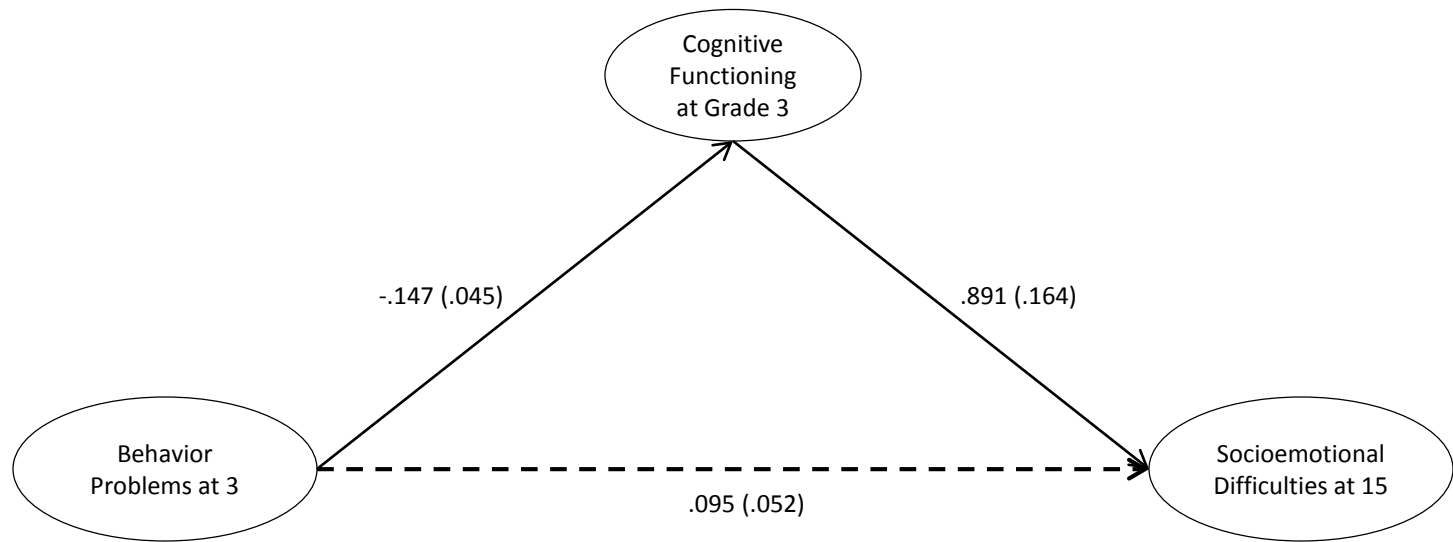


Figure 5. The Mediating Role of Cognitive Functioning in Grade 3 in an Association between Behavior Problems at 3 Years and Socioemotional Difficulties at 15 Years.

Note: Standardized estimates (β) and standardized errors (SE) are shown here. The lines in the figure are about direct paths between the two variables after accounting for the remaining variables. The total effect between an association between socioemotional difficulties at 3 years and socioemotional difficulties at 15 years was $\beta=.454$, $SE=.034$, $p=.002$ and the indirect effect was $\beta=.359$, $SE=.038$, $p=.001$.

Summary



- Sleep problems at age 3 years are significantly and directly related to behavior problems at age 3 years
- Sleep problems do not have any direct longitudinal relations with socioemotional difficulties or cognitive difficulties
- Even though early sleep problems influence early behavior problems to some extent, however, behavior problems in the preschool years might matter more to later socioemotional and cognitive functioning than do early sleep problems

Summary (cont.)



- When young children demonstrated fewer social behavior problems in their early years, these children demonstrated better functioning in their later socioemotional and cognitive development
- Social behaviors in age 3 and grade 1, and Cognitive functioning in grade 1 and 3 are predictors that showed a stronger impact on later functioning.

Question: Can individual differences in the cognitive and socioemotional functioning of adolescents be predicted from sleep and social behaviors in early childhood?

- The individual differences in the cognitive and socioemotional functioning of adolescents can be predicted from behavior problems and from sleep problems to some extent in early childhood.
- Later cognitive and socioemotional functioning in adolescence was related more to behavior problems in the children's early years than to their sleep problems.
- Yet, the role of sleep problems cannot be ignored since sleep problems did relate to behavior problems and that behavior problems were related to later socioemotional difficulties and cognitive functioning.

Question: Is the prediction from early childhood experiences to later cognitive and socioemotional outcomes influenced more by children's experiences during the first 3 years of life or by developmental experiences?."

- The prediction from early childhood experiences to later cognitive and socioemotional outcomes is indeed influenced by children's experiences during their first 3 years of life and by their developmental experiences (Eisenberg, 1995; Iglowstein, Jenni, Molinari, & Largo, 2012).
- The children who had behavior problems during their preschool years tended to show socioemotional difficulties in their elementary years and that lasted until their adolescence.
- Highlights the importance of the role of early social behaviors during their preschool years and the preventive and intervention efforts that parents and educators need to pay attention to.

Limitations/Future Study

- Interactions between sleep problems and behavior problems
- Other mediators or control variables that were not included
- Did not explore sleep, social behaviors and cognitive and socioemotional functioning beyond the variables we used. Investigating other related variables could have produced other important results.
- Did not to include sleep variables at age 15 years based on the analyses in this study. Future research is needed in this area.
- Sleep problems need to be studied in conjunction with other significant developmental characteristics like behavior problems as employed in this study, rather than being studied alone, when investigating their relationship with later functioning

Contribution



- Through an analysis of children's trajectories from early childhood to adolescence
- The findings elucidate previously unexplored yet significant growth patterns that could encourage success.
- Sought to determine the baseline effects of sleep and social behaviors on later functioning for use in subsequent studies and evaluations.
- Educators and parents need to be aware that those children who are tired, inattentive, and restless, either due to sleep problems or due to the presence of less developed social behaviors or both, may be less able to participate in the learning opportunities available in their classrooms intended to facilitate the development of cognitive and social skills.

Conclusion

- Sleep problems at age 3 are associated with behavior problems at age 3.
- Behavior problems at age 3 are associated with later functioning at age 15.
- The role of early sleep problems in later functioning is not large in magnitude.
- Socioemotional difficulties in age 3 and grade 3 mediate the relationship between sleep and later functioning.
- Cognitive functioning in grade 1 and 3 mediate the relationship between problems at age 3 and socioemotional difficulties at 15 years.
- Sleep problems influence behavior problems to some extent, but not vice versa.

□ ***Thank you for your participation!***

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