**Supplementary Analyses**

**Table S1**

*Descriptive statistics of infant and mother RSA during free-play at 6 months (166 dyads, 12 epochs for RSA data)*

|  |  |  |
| --- | --- | --- |
|   | Infant RSA | Mother RSA |
| Epoch | *N* | Missing Rate % | *M* | *SD* | Range | *N* | Missing Rate % | *M* | *SD* | Range |
| 1 | 164 | 1.2 | 3.01 | 0.86 | 1.08-5.36 | 162 | 2.4 | 4.84 | 1.02 | 2.04-7.57 |
| 2 | 164 | 1.2 | 3.02 | 0.80 | 1.21-5.06 | 162 | 2.4 | 4.70 | 1.04 | 2.07-7.42 |
| 3 | 164 | 1.2 | 3.12 | 0.86 | 1.22-5.36 | 166 | .0 | 4.61 | 1.08 | 2.25-7.33 |
| 4 | 163 | 1.8 | 3.09 | 0.85 | 1.30-5.24 | 158 | 4.8 | 4.75 | 1.10 | 2.19-7.56 |
| 5 | 165 | .6 | 3.02 | 0.83 | 1.02-5.22 | 163 | 1.8 | 4.70 | 1.07 | 2.05-7.62 |
| 6 | 165 | .6 | 3.06 | 0.90 | 1.10-5.07 | 162 | 2.4 | 4.64 | 1.08 | 2.18-7.20 |
| 7 | 163 | 1.8 | 3.07 | 0.91 | 1.13-5.34 | 162 | 2.4 | 4.78 | 1.11 | 2.07-6.96 |
| 8 | 162 | 2.4 | 3.15 | 0.85 | 1.34-5.37 | 164 | 1.2 | 4.78 | 1.13 | 2.10-7.28 |
| 9 | 158 | 4.8 | 3.01 | 0.83 | 1.12-5.18 | 163 | 1.8 | 4.78 | 1.13 | 2.28-7.12 |
| 10 | 161 | 3.0 | 3.09 | 0.92 | 1.27-5.30 | 162 | 2.4 | 4.80 | 1.03 | 2.10-7.40 |
| 11 | 161 | 3.0 | 3.09 | 0.93 | 1.26-5.27 | 162 | 2.4 | 4.82 | 1.10 | 2.21-7.68 |
| 12 | 156 | 6.0 | 3.11 | 0.89 | 1.09-5.34 | 154 | 7.2 | 4.73 | 1.10 | 2.27-7.99 |

**Table S2**

*Multilevel SEM analyses of the effects of mother-infant RSA synchrony during free-play and maternal depressive symptoms at 6 months on children’s internalizing problems at 24 months (****all******covariates controlled****, N = 166 dyads)*

|  |  |  |
| --- | --- | --- |
|  **RSA Synchrony Model Coefficients** | **Infant Model (Mother RSA🡪 Infant RSA)** | **Mother Model (Infant RSA 🡪 Mother RSA)** |
| Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* |
| **Fixed effect** |  |  |  |  |  |  |  |  |  |  |  |  |
| Intercept of RSA | 3.05 | 0.06 | < .001\*\*\* | 3.05 | 0.06 | < .001\*\*\* | 4.70 | 0.08 | < .001\*\*\* | 4.70 | 0.08 | < .001\*\*\* |
| Time effect | 0.004 | 0.01 | .49 | 0.004 | 0.01 | .46 | 0.01 | 0.01 | .31 | 0.01 | 0.01 | .30 |
| RSA synchrony | 0.04 | 0.02 | .02\* | 0.04 | 0.02 | .02\* | 0.08 | 0.03 | .009\*\* | 0.08 | 0.03 | .009\*\* |
| **Random effect (Variance)**  |  |  |  |  |  |  |  |  |  |  |  |  |
| Intercept of RSA | 0.42 | 0.05 | < .001\*\*\* | 0.42 | 0.05 | < .001\*\*\* | 0.65 | 0.07 | < .001\*\*\* | 0.65 | 0.07 | < .001\*\*\* |
| Time effect | 0.002 | 0.00 | < .001\*\*\* | 0.002 | 0.00 | < .001\*\*\* | 0.002 | 0.00 | < .001\*\*\* | 0.002 | 0.00 | < .001\*\*\* |
| RSA synchrony | 0.01 | 0.01 | .09\*\* | 0.01 | 0.004 | .03\* | 0.02 | 0.01 | .07† | 0.02 | 0.01 | .02\* |
| **Effect on Internalizing Problems (24 months)** | **Main-effect-model** | **Interaction-effect-model** | **Main-effect-model** | **Interaction-effect-model** |
| Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* |
| Intercept | 9.86 | 1.03 | < .001\*\*\* | 9.92 | 0.70 | < .001\*\*\* | 9.96 | 1.01 | < .001\*\*\* | 10.01 | 0.74 | < .001\*\*\* |
| **6-month Predictors** |  |  |  |  |  |  |  |  |  |  |  |  |
| MDS | 0.29 | 0.16 | .07† | 0.65 | 0.23 | **.005\*\*** | 0.29 | 0.16 | .08† | 0.68 | 0.23 | **.003\*\*** |
| RSA synchrony  | -0.88 | 21.53 | .97 | -4.58 | 10.12 | .65 | -1.77 | 10.89 | .87 | -3.26 | 6.22 | .60 |
| MDS\*RSA synchrony | – | – | – | -7.50 | 2.53 | **.003\*\*** | – | – | – | -4.32 | 1.65 | **.009\*\*** |
| Infant age | -0.26 | 0.78 | .74 | -0.24 | 0.78 | .76 | -0.24 | 0.78 | .76 | -0.28 | 0.78 | .72 |
| Gender  | -1.05 | 0.56 | .06† | -0.98 | 0.56 | .08† | -1.04 | 0.56 | .06† | -0.97 | 0.56 | .08† |
| Infant BMI | 0.08 | 0.11 | .44 | 0.07 | 0.10 | .52 | 0.08 | 0.10 | .45 | 0.07 | 0.10 | .53 |
| Infant negative affect | -0.01 | 0.03 | .66 | -0.01 | 0.03 | .64 | -0.01 | 0.03 | .65 | -0.01 | 0.03 | .64 |

*Note*. Estimate, unstandardized path coefficients. RSA, Respiratory sinus arrhythmia. MDS, maternal depressive symptoms. RSA synchrony was the slope of an individual’s RSA predicted by the partner’s person-mean-centered state RSA over time. Results for both the main-effect model and interaction-effect model were presented in this table. Significant predicting effects on child internalizing problems were bolded. †*p* < 0.1. \**p* < 0.05. \*\**p* < 0.01. \*\*\**p* < 0.001.

**Table S3**

*Multilevel analyses of the concurrent association between maternal depressive symptoms, infant negative affect, and mother-infant RSA synchrony at 6 months (****predictors of RSA synchrony****, N = 166 dyads).*

|  |  |  |
| --- | --- | --- |
| **Dependent RSA** | **Infant Model (Mother RSA🡪 Infant RSA)** | **Mother Model (Infant RSA 🡪 Mother RSA)** |
| Estimate | *SE* | *p* | Estimate | *SE* | *p* |
| **Fixed effect** |  |  |  |  |  |  |
| Intercept (Average RSA) | 3.05 | 0.06 | < .001\*\*\* | 4.70 | 0.08 | < .001\*\*\* |
| Time effect | 0.003 | 0.01 | .54 | 0.01 | 0.01 | .31 |
| Partner’s State RSA (RSA synchrony) |  |  |  |  |  |  |
|  \*Intercept  | 0.04 | 0.02 | .02\* | 0.09 | 0.03 | .003\*\* |
|  \*Infant age | 0.04 | 0.02 | **.04\*** | 0.07 | 0.04 | **.04\*** |
|  \*Gender | 0.03 | 0.02 | .11 | 0.05 | 0.03 | .06† |
|  \*Infant BMI | -0.004 | 0.004 | .29 | -0.01 | 0.01 | .20 |
|  \*Infant negative affect | 0.0001 | 0.001 | .91 | 0.0003 | 0.002 | .87 |
|  \*Maternal depressive symptoms | 0.00003 | 0.003 | .99 | -0.001 | 0.01 | .93 |
| **Random effect (Variance)**  |  |  |  |  |  |  |
| Intercept (Average RSA) | 0.42 | 0.05 | < .001\*\*\* | 0.65 | 0.07 | < .001\*\*\* |
| Time effect | 0.002 | 0.00 | < .001\*\*\* | 0.002 | 0.00 | < .001\*\*\* |
| RSA synchrony | 0.01 | 0.004 | .06† | 0.02 | 0.01 | .10 |

*Note*. Estimate, unstandardized path coefficients. RSA, Respiratory sinus arrhythmia. RSA synchrony was the slope of an individual’s RSA predicted by the partner’s person-mean-centered state RSA over time. The cross-level interaction between the partner’s state RSA and predictors (e.g., infant age) reflects the moderation effects of predictors on RSA synchrony. Significant moderation effects were bolded. Variance for RSA synchrony is the residual variance that cannot be explained by predictors. †*p* < 0.1. \**p* < 0.05. \*\**p* < 0.01. \*\*\**p* < 0.001.

***The equation for examining predictors of RSA synchrony.***

*Level 1*: Infant\_RSA*jt*​ =$β$0*j*​ + $β$1*j* (Mother\_RSA*jt* ) + $β$2*j* Time*t* +*rjt*

*Level 2*

$β$0*j*​ = $γ$00 + $μ$0*j*

$β$1*j* = $γ$10 + $γ$11(Age) + $γ$12(Gender) + $γ$13(BMI) + $γ$14(Negative affect) + $γ$15(Maternal depressive symptoms) + $μ$1*j*

$β$2*j* = $γ$20 +$μ$2*j*

Infant\_RSA*jt*​ = $γ$00 + $μ$0*j* + $γ$10(Mother\_RSA*jt* ) + $γ$11(Age) (Mother\_RSA*jt* ) + $γ$12(Gender) (Mother\_RSA*jt* ) + $γ$13(BMI) (Mother\_RSA*jt* )+ $γ$14(Negative affect) (Mother\_RSA*jt* ) + $γ$15(Maternal depressive symptoms) (Mother\_RSA*jt* ) + $μ$1*j*(Mother\_RSA*jt* ) + $β$2*j* Time*t* +*rjt*

In this equation, a cross-level interaction term between a predictor (e.g., infant age) and one partner’s state RSA (predictor-x-RSA) represented how the level of synchrony between two partners was shaped by the different levels of the predictor (e.g., infant age). Continuous predictors (e.g., infant age) were grand-mean centered to get a meaningful intercept for RSA synchrony and minimize multicollinearity between predictors.

**Table S4**. *Multilevel model estimation of mother-infant RSA change over time during free-play at 6 months (****testing linear and quadratic time trends of RSA****, N = 166 dyads)*

|  |  |  |
| --- | --- | --- |
|   | **Infant RSA** | **Mother RSA** |
|   | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* |
| **Fixed effect** |  |  |  |  |  |  |  |  |  |  |  |  |
| Intercept of RSA | 3.04 | 0.06 | < .001\*\*\* | 3.04 | 0.06 | < .001\*\*\* | 4.69 | 0.07 | < .001\*\*\* | 4.72 | 0.08 | < .001\*\*\* |
| **Linear time trend** | 0.004 | 0.01 | .40 | 0.01 | 0.01 | .57 | 0.01 | 0.01 | .26 | -0.01 | 0.02 | .56 |
| **Quadratic time trend** | – | – | – | 0.00 | 0.001 | .85 | – | – | – | 0.001 | 0.001 | .31 |
| **Random effect (Variance)**  |  |  |  |  |  |  |  |  |  |  |  |  |
| Intercept of RSA | 0.42 | 0.06 | < .001\*\*\* | 0.42 | 0.06 | < .001\*\*\* | 0.66 | 0.09 | < .001\*\*\* | 0.66 | 0.09 | < .001\*\*\* |
| **Linear time trend** | 0.002 | 0.00 | **< .001\*\*\*** | 0.001 | 0.001 | **.02\*** | 0.002 | 0.001 | **< .001\*\*\*** | 0.002 | 0.001 | **.049\*** |
| **Quadratic time trend** | – | – | – | 0.00 | 0.00 | .13 | – | – | – | 0.00 | 0.00 | .59 |

*Note*. Estimate, unstandardized path coefficients. RSA, Respiratory sinus arrhythmia. Time trend was the linear or quadratic slopes of RSA change over time throughout the free-play task. Linear trends were tested before adding quadratic trends. Significant time effects were bolded. †*p* < 0.1. \**p* < 0.05. \*\**p* < 0.01. \*\*\**p* < 0.001.

**Table S5**. *Multilevel SEM analyses of the effects of mother-infant RSA synchrony during free-play and maternal depressive symptoms at 6 months on children’s internalizing problems at 24 months (****including quadratic time effect and excluding time effect in RSA synchrony estimation****, N = 166 dyads)*

|  |  |  |
| --- | --- | --- |
|   | **Infant Model (Mother RSAà Infant RSA)**  | **Mother Model (Infant RSA à Mother RSA)** |
|  | **Including quadratic time effect** | **Excluding time effect** | **Including quadratic time effect** | **Excluding time effect** |
| **RSA Synchrony Model Coefficients** | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* |
| **Fixed effect** |  |  |  |  |  |  |  |  |  |  |  |  |
| Intercept of RSA | 3.05 | 0.09 | < .001\*\*\* | 3.07 | 0.05 | < .001\*\*\* | 4.70 | 0.11 | < .001\*\*\* | 4.73 | 0.07 | < .001\*\*\* |
| Linear time trend | 0.004 | 0.02 | .84 | – | – | – | -0.003 | 0.02 | .91 | – | – | – |
| Quadratic time trend | 0.00 | 0.002 | .98 | – | – | – | 0.001 | 0.002 | .67 | – | – | – |
| RSA synchrony | 0.04 | 0.02 | .02\* | 0.05 | 0.02 | .009\*\* | 0.08 | 0.03 | .01\* | 0.08 | 0.03 | .01\* |
| **Random effect (Variance)**  |  |  |  | – | – | – |  |  |  | – | – | – |
| Intercept of RSA | 0.42 | 0.05 | < .001\*\*\* | 0.44 | 0.05 | < .001\*\*\* | 0.65 | 0.07 | < .001\*\*\* | 0.68 | 0.07 | < .001\*\*\* |
| Linear time trend | 0.002 | 0.00 | < .001\*\*\* | – | – | – | 0.002 | 0.00 | < .001\*\*\* |  |  |  |
| RSA synchrony | 0.01 | 0.003 | .02\* | 0.01 | 0.004 | .10 | 0.02 | 0.01 | .02\* | 0.01 | 0.01 | .14 |
| **Effect on Internalizing Problems (24 months)** | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* |
| Intercept | 9.98 | 0.77 | < .001\*\*\* | 10.15 | 0.85 | < .001\*\*\* | 10.01 | 0.75 | < .001\*\*\* | 10.18 | 0.89 | < .001\*\*\* |
| **6-month Predictors** |  |  |  |  |  |  |  |  |  |  |  |  |
| MDS | 0.71 | 0.26 | **.006\*\*** | 0.79 | 0.28 | **.004\*\*** | 0.68 | 0.24 | **.005\*\*** | 0.81 | 0.28 | **.004\*\*** |
| RSA synchrony  | -6.60 | 12.33 | .59 | -8.71 | 11.69 | .46 | -3.45 | 6.31 | .59 | -5.55 | 8.18 | .50 |
| MDS**\***RSA synchrony | -9.24 | 2.85 | **.001\*\*** | -8.92 | 3.21 | **.005\*\*** | -4.34 | 1.70 | **.01\*** | -5.71 | 2.39 | **.02\*** |
| Gender  | -0.97 | 0.53 | .07† | -0.98 | 0.53 | .07† | -0.97 | 0.54 | .07† | -0.98 | 0.53 | .07† |

*Note*. Estimate, unstandardized path coefficients. RSA, Respiratory sinus arrhythmia. MDS, maternal depressive symptoms. RSA synchrony was the slope of RSA predicted by the partner’s state RSA over time. Only the fixed quadratic effect of time was included in the model given random quadratic effect was non-significant. Only the interaction-effect-model results were presented in this table. Significant predicting effects on child internalizing problems were bolded. †*p* < 0.1. \**p* < 0.05. \*\**p* < 0.01. \*\*\**p* < 0.001.

**Table S6**. *Multilevel SEM analyses of the effects of mother-infant RSA synchrony during free-play and maternal depressive symptoms at 6 months on children’s internalizing problems at 24 months (****complete case analyses; N = 115 dyads****)*

|  |  |  |
| --- | --- | --- |
|  **RSA Synchrony Model Coefficients** | **Infant Model (Mother RSA🡪 Infant RSA)** | **Mother Model (Infant RSA 🡪 Mother RSA)** |
| Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* |
| **Fixed effect** |  |  |  |  |  |  |  |  |  |  |  |  |
| Intercept of RSA | 3.07 | 0.08 | < .001\*\*\* | 3.07 | 0.08 | < .001\*\*\* | 4.72 | 0.10 | < .001\*\*\* | 4.72 | 0.10 | < .001\*\*\* |
| Time effect | 0.002 | 0.01 | .78 | 0.002 | 0.01 | .74 | 0.01 | 0.01 | .09† | 0.01 | 0.01 | .08 |
| RSA synchrony | 0.04 | 0.02 | .04\* | 0.04 | 0.02 | .05\* | 0.07 | 0.03 | .03\*\* | 0.07 | 0.03 | .03\* |
| **Random effect (Variance)**  |  |  |  |  |  |  |  |  |  |  |  |  |
| Intercept of RSA | 0.42 | 0.06 | < .001\*\*\* | 0.42 | 0.06 | < .001\*\*\* | 0.73 | 0.1 | < .001\*\*\* | 0.73 | 0.10 | < .001\*\*\* |
| Time effect | 0.002 | 0.00 | < .001\*\*\* | 0.002 | 0.00 | < .001\*\*\* | 0.002 | 0.001 | < .001\*\*\* | 0.002 | 0.001 | < .001\*\*\* |
| RSA synchrony | 0.004 | 0.01 | .40 | 0.01 | 0.003 | .18 | 0.02 | 0.01 | .27 | 0.01 | 0.01 | .18 |
| **Effect on Internalizing Problems (24 months)** | **Main-effect model** | **Interaction-effect model** | **Main-effect model** | **Interaction-effect model** |
| Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* | Estimate | *SE* | *p* |
| Intercept | 9.80 | 1.61 | < .001\*\*\* | 9.83 | 0.79 | < .001\*\*\* | 10.09 | 1.37 | < .001\*\*\* | 10.03 | 1.03 | < .001\*\*\* |
| **6-month Predictors** |  |  |  |  |  |  |  |  |  |  |  |  |
| MDS | 0.30 | 0.17 | .07† | 0.72 | 0.27 | **.008\*\*** | 0.29 | 0.17 | .07† | 0.88 | 0.31 | **.004\*\*** |
| RSA synchrony  | -1.53 | 40.84 | .97 | -5.02 | 14.40 | .73 | -4.78 | 16.52 | .77 | -5.48 | 12.19 | .65 |
| MDS**\***RSA synchrony | – | – | – | -10.28 | 3.68 | **.005\*\*** | – | – | – | -7.88 | 2.83 | **.005\*\*** |
| Gender  | -1.06 | 0.54 | .05† | -0.97 | 0.53 | .07† | -1.04 | 0.54 | .06† | -0.96 | 0.53 | .07† |

*Note*. Estimate, unstandardized path coefficients. RSA, Respiratory sinus arrhythmia. MDS, maternal depressive symptoms. RSA synchrony was the slope of an individual’s RSA predicted by the partner’s person-mean-centered state RSA over time. Results for both the main-effect model and interaction-effect model were presented in this table. Significant predicting effects on child internalizing problems were bolded. †*p* < 0.1. \**p* < 0.05. \*\**p* < 0.01. \*\*\**p* < 0.001.



**Figure S1.** Estimated factor scores of the latent mother-infant RSA synchrony for each dyad (*N* =166) from multilevel SEM model (Infant model: Mother RSA 🡪 Infant RSA). Mother-infant RSA synchrony: Mean = 0.04, *SD* = 0.04, Range = -0.07 to 0.16, 16 % synchrony (26 dyads) falling below zero, 84% (139 dyads) above zero, 46% below average, 54% higher than average.