Which life course theoretical models best explain the relationship between childhood adversity and depressive symptoms in adolescence?

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Depression: a major public health issue

It is common throughout the lifespan,

is associated with many consequences,

and is the leading cause of disability worldwide.


Preventing depression is key

...because it strikes when people are young and once it emerges, it is highly recurrent.

1/3 of people with major depressive disorder had their first onset between ages 13-21.

3/4 of people with depression will experience a relapse at some point in their lives.

Conclusion: We need to better understand the etiology of depression in order to prevent its occurrence as early on in the lifespan as possible.


Warden D, et al. (2007). Current Psychiatry Reports,
Exposure to stress/adversity is a potent risk factor for depression.

- Divorce/marital discord
- Poverty
- Accidents/Injury
- Natural disasters
- Child abuse/neglect
- Witnessing violence
- Death of a loved one
- Illness
- Parent psychopathology
- Illness
How might childhood adversity increase subsequent risk for depression?

Theoretical Models

Implications for Intervention

Exposure

Accumulation

Recency

Sensitive Period

Age at Exposure to Adversity

Infancy Early Childhood Childhood Adolescence

High risk period: “window of vulnerability”
High reward period: “window of opportunity”

Intervene now

Intervene early

Intervene quickly

High

Exposed to Adversity

Low

Unexposed to Adversity

Depression Risk

Number of Adversity Exposures

Time Since Onset of Exposure

Exposed to Adversity

Intervene at any time

Unexposed to Adversity

Depression Risk

Exposed

Unexposed

Depression Risk
In the current study, we aimed to:

- Identify sensitive periods in development when exposure to adversity confers a particularly high risk for depression, and
- Test whether the effects of adversity during sensitive periods are still observable even if we account for other theoretical models.
Sample: ALSPAC

Avon Longitudinal Study of Parents and Children (ALSPAC)  
n=~14,000

Two types of caregiver reported adversity
- Caregiver physical or emotional abuse
- Financial stress/poverty

Each assessed repeatedly from birth to age 18

Challenges
- Children can be exposed repeatedly throughout their lifespan
  Working with repeated, and often correlated, exposures

Depression (Short Moods & Feelings)

Analytic Approach

• Structured lifecourse modeling approach (SLCMA) to analyze repeated binary exposure data across the lifecourse

• Simultaneously evaluate different pre-specified theoretical models, each describing the association between exposure to adversity and depressive symptoms at age 18
  • Sensitive period model
  • Accumulation model
  • Recency model

• Step 1: Identify best fitting theoretical models (based on r2) for each adversity type using least angle regression (LARS)
  • Recorded the best fitting theoretical model(s) chosen by the LARS procedure, (determined by a covariance test p-value threshold of 0.05)

• Step 2: Test best fitting models using standard linear regression to obtain estimates of effect

Smith, A.D.A.C., Heron, J., Mishra, G., Gilthorpe, M.S., Ben-Shlomo-Y., & Tilling, K. (2015). *Epidemiology*
Overview of LARS with LASSO Estimation

Code each theoretical model into an encoded variable:
- **sensitive_3**: 0=unexposed; 1=exposed
- **accumulation**: sum of number of time points exposed;
- **recency**: accumulation score weighted by time period

Enter each encoded variable into least angle regression (LARS) using LASSO as estimation procedure

LASSO = Least Absolute Shrinkage and Selection Operator

Imposes an “absolute value penalty” on the parameter estimates, in essence reducing effect estimates with already small effects to zero

LASSO aids in achieving parsimony by identifying the smallest combination of encoded variables that explain the most amount of outcome variation

Smith, A.D.A.C., Heron, J., Mishra, G., Gilthorpe, M.S., Ben-Shlomo-Y., & Tilling, K. (2015). *Epidemiology*
Interpreting LARS Results

Results are summarized in an “elbow plot”

Increase in overall r2 as additional predictors are added to the model

Also evaluate quantitatively through covariance hypothesis test

<table>
<thead>
<tr>
<th>Variable</th>
<th>Drop in covariance</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17.396</td>
<td>0.0012</td>
</tr>
<tr>
<td>2</td>
<td>1.2234</td>
<td>0.0438</td>
</tr>
<tr>
<td>3</td>
<td>0.8836</td>
<td>0.1734</td>
</tr>
<tr>
<td>4</td>
<td>0.0023</td>
<td>0.5672</td>
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<tr>
<td>5</td>
<td>0.0001</td>
<td>0.9738</td>
</tr>
<tr>
<td>6</td>
<td>0.0020</td>
<td>0.9803</td>
</tr>
</tbody>
</table>

Smith, A.D.A.C., Heron, J., Mishra, G., Gilthorpe, M.S., Ben-Shlomo-Y., & Tilling, K. (2015). *Epidemiology*
Ran analyses in two phases to address different questions:

- **Phase 1**: Are there sensitive periods when exposure to adversity confers a particularly high risk for depression?
  - Testing *only* sensitive periods

- **Phase 2**: Does these sensitive periods effects persist even after accounting for other theoretical models, like accumulation or recency?
  - Accumulation model
  - Recency model
  - Sensitive periods

Smith, A.D.A.C., Heron, J., Mishra, G., Gilthorpe, M.S., Ben-Shlomo-Y., & Tilling, K. (2015). *Epidemiology*
• To reduce potential bias and minimize loss of power due to attrition, we performed multiple imputation, separately for each exposure, using logistic regression in 20 datasets with 25 iterations each among all children with complete data on the outcome.

• We controlled for the following covariates, measured at child birth:
  • Child race/ethnicity
  • Pregnancy size
  • Number of previous pregnancies
  • Maternal marital status
  • SES-indicators: Highest level of maternal education, Maternal age, Homeownership, and Parent social class

• We also adjusted for maternal psychopathology measured during pregnancy to reduce potential impacts of confounding, as mothers were the primary reporters of their child’s exposure to adversity, and maternal mood may influence this.

• All analyses were stratified by sex, given known sex differences in depression risk.
Adversities were common, but not correlated across type

Prevalence ever exposed to either adversity type
44%

Correlation ever exposed between types
$r = 0.11$
Adversities were correlated across time

Table 1. Tetrachoric correlations for caregiver physical or emotional abuse

<table>
<thead>
<tr>
<th>Age</th>
<th>8 mo.</th>
<th>1.75 y</th>
<th>2.75 y</th>
<th>4 y</th>
<th>5 y</th>
<th>6 y</th>
<th>9 y</th>
<th>11 y</th>
<th>18y</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 mo.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.75 years</td>
<td>0.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.75 years</td>
<td>0.64</td>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 years</td>
<td>0.59</td>
<td>0.70</td>
<td>0.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>0.60</td>
<td>0.57</td>
<td>0.64</td>
<td>0.73</td>
<td></td>
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</tr>
<tr>
<td>6 years</td>
<td>0.56</td>
<td>0.55</td>
<td>0.57</td>
<td>0.66</td>
<td>0.77</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>9 years</td>
<td>0.50</td>
<td>0.51</td>
<td>0.47</td>
<td>0.63</td>
<td>0.64</td>
<td>0.56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 years</td>
<td>0.40</td>
<td>0.37</td>
<td>0.34</td>
<td>0.43</td>
<td>0.47</td>
<td>0.46</td>
<td>0.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 years</td>
<td>0.45</td>
<td>0.34</td>
<td>0.39</td>
<td>0.40</td>
<td>0.42</td>
<td>0.42</td>
<td>0.48</td>
<td>0.6</td>
<td></td>
</tr>
</tbody>
</table>
Adversities were correlated across time

Table 2. Tetrachoric correlations for financial stress

<table>
<thead>
<tr>
<th>Age</th>
<th>8 mo.</th>
<th>1.75 y</th>
<th>2.75 y</th>
<th>5 y</th>
<th>7 y</th>
<th>11 y</th>
<th>18 y</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 mo.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.75 years</td>
<td>0.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.75 years</td>
<td>0.72</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>0.53</td>
<td>0.60</td>
<td>0.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 years</td>
<td>0.52</td>
<td>0.54</td>
<td>0.46</td>
<td>0.65</td>
<td></td>
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</tr>
<tr>
<td>18 years</td>
<td>0.47</td>
<td>0.44</td>
<td>0.51</td>
<td>0.47</td>
<td>0.51</td>
<td>0.51</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Girls had more depressive symptoms

Average SMFQ score for boys: 5.34

Average SMFQ score for girls: 7.64

Girls on average had significantly more depressive symptoms (p<.001)
### Phase 1: Identifying sensitive periods

#### Table 3. Results of LASSO models on multiply imputed data, testing only sensitive periods models

<table>
<thead>
<tr>
<th>Girls (n=2153)</th>
<th>Model(s) selected</th>
<th>R²</th>
<th>P Value</th>
<th>β</th>
<th>S.E.</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parental Cruelty</td>
<td>Sensitive period at 11 years</td>
<td>0.18%</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Stress</td>
<td>Sensitive period at 1.75 years</td>
<td>0.38%</td>
<td>0.01**</td>
<td>1.93</td>
<td>0.49</td>
<td>0.95</td>
<td>2.92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Boys (n=1183)</th>
<th>Model(s) selected</th>
<th>R²</th>
<th>P Value</th>
<th>β</th>
<th>S.E.</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parental Cruelty</td>
<td>Sensitive period at 9 years</td>
<td>0.40%</td>
<td>0.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Stress</td>
<td>Sensitive period at 2.75 years</td>
<td>0.42%</td>
<td>0.03*</td>
<td>1.16</td>
<td>0.50</td>
<td>0.12</td>
<td>2.19</td>
</tr>
</tbody>
</table>

Models significant at *p < .05 in bold
### Table 4. Results of LASSO models on multiply imputed data, testing accumulation, recency, and sensitive periods models

<table>
<thead>
<tr>
<th></th>
<th>Model(s) selected</th>
<th>$R^2$</th>
<th>P Value</th>
<th>$\beta$</th>
<th>S.E.</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Girls (n=2153)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental Cruelty</td>
<td>Accumulation</td>
<td>0.10%</td>
<td>0.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Stress</td>
<td>Accumulation</td>
<td>0.09%</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Boys (n=1183)</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>0.40%</td>
<td>0.07</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>at 9 years</td>
<td></td>
<td></td>
<td></td>
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<td>Financial Stress</td>
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<td>2.19</td>
</tr>
<tr>
<td></td>
<td>at 2.75 years</td>
<td></td>
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</tr>
</tbody>
</table>

Models significant at *$p < .05$ in bold
Conclusions

• Very early childhood (age 0-3) seems to be a sensitive period when exposure to financial stress has a particularly strong effect on depressive symptoms in adolescence for both boys and girls.

• For boys, the effect of this sensitive period persists even after accounting for other theoretical models.
  • In other words, the developmental timing of exposure to financial stress explains more variability in depression at age 18 than the number of time points exposed or the recency of exposure.

• Although these results should be replicated, they suggest the need to move beyond crude comparisons of those exposed vs. unexposed to “early life” adversity.
Lab Members and Funding Support

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Thank you!

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Meg Min-Jung Wang
Yiwen Zhu

Prospective Study of Young Children

Avon Longitudinal Study of Parents and Children (ALSPAC) n=6,000

Caregiver physical or emotional abuse

What theoretical model best explains variation: Accumulation, recency, or sensitive period?

Behavior problems

Effects of adversity vary by sex

Boys

Behavior problems

Accumulation

r² = 1.71%

Girls

Behavior problems

Recency

r² = 1.55%

Exposure to adversity

1.5 years 2.5 years 3.5 years 4.75 years 5.75 years 6.75 years 8 years

1 time 2 times 3 times 4 times 5 times 6 times

Behavior problems

Time since exposure

Count of exposures

Boys

Accumulation

r² = 1.71%

Girls

Recency

r² = 1.55%

Boys

Accumulation

r² = 1.71%

Girls

Recency

r² = 1.55%

Boys

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r² = 1.71%

Girls

Recency

r² = 1.55%

Boys

Accumulation

r² = 1.71%
<table>
<thead>
<tr>
<th>Exposures</th>
<th>Construct</th>
<th>Measurement Tool</th>
<th>Sample Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caregiver physical or emotional abuse</td>
<td>Mother-completed questionnaire</td>
<td>Mother’s partner was physically cruel to child in past year</td>
<td></td>
</tr>
<tr>
<td>Financial stress</td>
<td>Mother-completed questionnaire</td>
<td>Mother finds it difficult to afford rent/mortgage</td>
<td></td>
</tr>
<tr>
<td>Depressive symptoms</td>
<td>Child-completed Short Moods and Feelings Questionnaire (SMFQ) (ranges from 0-26)</td>
<td>In the past two weeks, respondent felt miserable or unhappy</td>
<td></td>
</tr>
</tbody>
</table>