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Krämer, Michael; Rohrer, Julia M.; Lucas, Richard E.; Richter, David

#### **Working Paper**

## Life events and life satisfaction: Estimating effects of multiple life events in combined models

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# 1204



# Life Events and Life Satisfaction: Estimating Effects of Multiple Life Events in Combined Models

Michael D. Krämer, Julia M. Rohrer, Richard E. Lucas, David Richter



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German Socio-Economic Panel (SOEP) DIW Berlin Mohrenstrasse 58 10117 Berlin, Germany Contact: soeppapers@diw.de



1	Life Events and Life Satisfaction: Estimating Effects of Multiple Life Events in
2	Combined Models
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4	Michael D. Krämer <sup>1,2,3</sup> , Julia M. Rohrer <sup>4</sup> , Richard E. Lucas <sup>5</sup> , and David Richter <sup>2,6</sup>
5	
6	<sup>1</sup> German Institute for Economic Research, Germany
7	<sup>2</sup> Freie Universität Berlin, Germany
8	<sup>3</sup> University of Zurich, Switzerland
9	<sup>4</sup> Leipzig University, Germany
10	<sup>5</sup> Michigan State University, USA
11	<sup>6</sup> SHARE Berlin Institute, Germany
12	
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- 14 Correspondence concerning this article should be addressed to Michael D. Krämer, University of
- 15 Zurich, Department of Psychology, Binzmuehlestrasse 14/7, CH-8050 Zurich. Email:

16 m.kraemer@psychologie.uzh.ch. Phone +41 44 635 75 23.

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#### 18 Author Note

- 19 Michael D. Krämer, https://orcid.org/0000-0002-9883-5676, Socio-Economic Panel (SOEP),
- 20 German Institute for Economic Research (DIW Berlin); Department of Education and

- 21 Psychology, Freie Universität Berlin; Individual Differences and Assessment, Department of
- 22 Psychology, University of Zurich
- 23 Julia M. Rohrer, https://orcid.org/0000-0001-8564-4523, Department of Psychology, Leipzig
- 24 University
- 25 Richard E. Lucas, https://orcid.org/0000-0002-7995-3319, Department of Psychology, Michigan
- 26 State University
- 27 David Richter, https://orcid.org/0000-0003-2811-8652, Department of Education and
- 28 Psychology, Freie Universität Berlin; SHARE Berlin Institute
- 29 The authors made the following contributions. Michael D. Krämer: Conceptualization, Data
- 30 Curation, Formal Analysis, Methodology, Visualization, Writing Original Draft Preparation;
- 31 Julia M. Rohrer: Conceptualization, Methodology, Writing Review & Editing; Richard E.
- 32 Lucas: Conceptualization, Methodology, Writing Review & Editing; David Richter:
- 33 Conceptualization, Supervision, Methodology, Writing Review & Editing.
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#### Abstract

46 How do life events affect life satisfaction? Previous studies focused on a single event or separate analyses of several events. However, life events are often grouped non-randomly over the 47 lifespan, occur in close succession, and are causally linked, raising the question of how to best 48 49 analyze them jointly. Here, we used representative German data (SOEP; N = 40,121 individuals; 50 n = 41,402 event occurrences) to contrast three fixed-effects model specifications: First, 51 individual event models in which other events were ignored, which are thus prone to 52 undercontrol bias; second, combined event models which controlled for all events, including subsequent ones, which may induce overcontrol bias; and third, our favored combined models 53 54 that only controlled for preceding events. In this preferred model, the events of new partner, 55 cohabitation, marriage, and childbirth had positive effects on life satisfaction, while separation, 56 unemployment, and death of partner or child had negative effects. Model specification made little 57 difference for employment- and bereavement-related events. However, for events related to romantic relationships and childbearing, small but consistent differences arose between models. 58 59 Thus, when estimating effects of new partners, separation, cohabitation, marriage, and childbirth, 60 care should be taken to include appropriate controls (and omit inappropriate ones) to minimize 61 bias.

*Keywords*: life events, life satisfaction, event co-occurrence, romantic relationships,childbirth

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#### Life Events and Life Satisfaction: Estimating Effects of Multiple Life Events in Combined Models

66 How do life events such as marriage or childbirth affect well-being? Extensive research addresses this question empirically by examining effects of events on subjective well-being. In 67 68 particular, studies often focus on life satisfaction, which is a global, cognitive component of 69 subjective well-being that some studies have shown to be more strongly affected than measures 70 of affective well-being (Diener et al., 1999; Luhmann, Hawkley, et al., 2012; Luhmann, 71 Hofmann, et al., 2012; Schimmack, 2008; cf. Asselmann & Specht, 2022, 2023 who have shown stronger effects for some facets of affect). Studies usually investigate life events in isolation and 72 73 present results of separate analyses of various individual events (e.g., Anusic et al., 2014a; Clark 74 et al., 2008; Clark & Georgellis, 2013; Denissen et al., 2019) or meta-analyses of such separate analyses (e.g., Luhmann, Hofmann, et al., 2012; Mangelsdorf et al., 2019). But life events are not 75 76 randomly spread over the life span; they often emerge as part of a common sequence (Hutteman et al., 2014) and are causally connected: for example, cohabitation may lead to marriage which 77 78 may lead to childbirth. Thus, there have been repeated calls to consider events jointly (Hentschel 79 et al., 2017; Luhmann, Orth, et al., 2014). To date, only a few studies have heeded these calls. 80 In this study, we investigate the effects of various life events in combined models of life 81 satisfaction. Control for other events can reduce confounding bias that may have affected 82 previous results-for example, changes in life satisfaction that have been attributed to the birth of 83 a child might in fact reflect the impact of preceding events such as cohabitation or marriage. But 84 such control can also induce its own biases, and successful causal identification always rests on 85 assumptions. Thus, we contrast different model specifications and compare the resulting 86 conclusions regarding the effects of life events on life satisfaction.

#### 87 Influence of Life Events on Life Satisfaction

88 Life events can be defined as "time-discrete transitions that mark the beginning or the end 89 of a specific status" (Luhmann, Hofmann, et al., 2012; p. 594). Examples include relationship 90 transitions (e.g., cohabitation, marriage, divorce), childbirth, the death of a relative or loved one 91 and changes in employment. It has previously been assumed that for the moderately time-stable 92 construct life satisfaction (Fujita & Diener, 2005; Gnambs & Buntins, 2017; Lucas & Donnellan, 93 2007), changes in response to such life events are temporary (Diener et al., 2006; Lykken & 94 Tellegen, 1996). This belief is part of set-point theory, which suggests that people return to 95 genetically determined baseline levels of well-being after the occurrence of changes in life 96 circumstances. However, more recent studies show long-term changes after particularly 97 disruptive events such as disability or unemployment (Lucas, 2007; Lucas et al., 2004; Luhmann, 98 Weiss, et al., 2014). In general (and perhaps unsurprisingly), studies report that positive life 99 events (such as marriage) increase life satisfaction whereas negative life events (such as loss of 100 loved ones or livelihood) decrease life satisfaction; although the details (such as magnitude of 101 change and its duration) vary (Luhmann, Krasko, et al., 2021; Luhmann & Intelisano, 2018).

#### 102 Previous Research Based on Individual Event Models

In addition to the following brief summary of central research findings on the effects of
individual life events, a more exhaustive overview of this vast body of literature can be found in
Table S1.

*Relationship Transitions.* Marriage is, on average, a positive event associated with
increased life satisfaction in anticipation of the event and for a few years afterwards (Clark &
Georgellis, 2013; Lucas et al., 2003). However, a recent analysis of four nationally representative
data sets found that cohabiting partners were similarly satisfied as married partners, especially
when controlling for selection effects and relationship satisfaction (Perelli-Harris et al., 2019; see

6

111 also Musick & Bumpass, 2012). Divorce, on the other hand, has been associated with life 112 satisfaction decreases in the years leading up to the event and recovery starting in the year 113 afterwards (Denissen et al., 2019; van Scheppingen & Leopold, 2020). 114 Entering a new partnership without living together with the partner was associated with 115 gains in life satisfaction compared to being single (Soons et al., 2009). Cohabitation is also 116 associated with increased life satisfaction (Kamp Dush & Amato, 2005; Perelli-Harris et al., 117 2019). Thus, there is prior evidence for a "continuum of commitment" (Kamp Dush & Amato, 118 2005, p. 610) in that a higher level of commitment in a romantic relationship on average brings

about higher life satisfaction. Other researchers, however, have found only temporary differences
between cohabiting and married couples, and have emphasized the importance of considering
concurrent life events (Musick & Bumpass, 2012; Perelli-Harris et al., 2019; Zimmermann &

122 Easterlin, 2006).

123 Childbirth. Childbirth has been found to be associated with increases to life satisfaction 124 already starting before the event and continuing for several years afterwards (Dyrdal & Lucas, 125 2013; Krämer & Rodgers, 2020). However, it is unclear whether the pre-event positive effects are 126 mostly due to other life events preceding first childbirth (e.g., cohabitation, marriage), and 127 whether adaptation occurs independent of events succeeding childbirth.

*Bereavement.* The death of one's spouse or child is characterized by a sharp decrease in life
satisfaction and slow adaptation afterwards (Asselmann & Specht, 2022; Doré & Bolger, 2018;
Infurna et al., 2017). To what extent complete adaptation occurs is debated (Anusic et al., 2014a;
Moor & de Graaf, 2016).

*Employment-related Life Events.* Unemployment is followed by a decrease in life
 satisfaction (Clark & Georgellis, 2013; Lawes et al., 2022b; Lucas et al., 2004). Depending on re employment (expectations), adaptation to pre-event levels might be slow or even incomplete

135 (Lawes et al., 2022a; Lucas et al., 2004). For retirement, the picture is less clear with some

136 research supporting short-time gains in life satisfaction (Hansson et al., 2020; Henning et al.,

137 2022), and other research finding no effect (Henning et al., 2016; Sohier et al., 2021).

#### 138 Previous Research Based on Combined Event Models

139 In contrast to such studies focusing on single events, prospective studies of life satisfaction 140 that model multiple events simultaneously, are sparse. For example, childbirth has been studied 141 in joint models with partnership and life stressors such as separation or illness (Dyrdal et al., 142 2019; Dyrdal & Lucas, 2013; Rudolf & Kang, 2015). These studies show that results can vary 143 depending on whether or not related events are modeled. For example, postpartum life 144 satisfaction trajectories differed depending on which concurrent life event parents experienced 145 (Dyrdal et al., 2019). The effects of partnership formation and breakup have also been 146 investigated jointly (Soons et al., 2009; Zimmermann & Easterlin, 2006). Results indicated that a 147 new partnership, cohabitation, and union dissolution were more consequential for life satisfaction than mere status changes like marriage and divorce (Soons et al., 2009). Becoming a parent did 148 149 not alter the effects of partnership transitions but only had beneficial effects on partnered parents. 150 To our knowledge, only one study on life satisfaction attempted to jointly model all 151 events available in a dataset. Kettlewell et al. (2020) used Australian panel data to estimate 152 effects of 22 life events on life satisfaction and affect comparing results from individual and 153 combined event models. The trajectories of life satisfaction-controlling for the occurrence of other life events-differed slightly from those of the individual event models. In general, effects 154 155 were closer to zero in the combined event models. The largest differences between the two types 156 of models emerged for the events reconciliation with a partner (where the partly negative effect

157 from the individual model shifted towards zero) and pregnancy (where the positive effect was

158 partly reversed).

#### 159 Methodological Considerations

#### 160 Causal Inference

161 Control for other events may reduce bias if one event confounds the effect of another one. 162 But controls are not always innocuous (Wysocki et al., 2022). From a causal inference 163 perspective, we see two potential problems in the estimation of the effects of a single event 164 conditional on all other events (i.e., including controls for events occurring after the focal event). 165 Both concerns can be subsumed under the term overcontrol bias. First, controlling for subsequent 166 events that are caused by the focal event will control away part of the causal effect of the event. 167 For example, people who find a new partner may start to cohabit subsequently, and this 168 cohabitation may have a direct positive effect on life satisfaction. This effect, which is mediated 169 via cohabitation, is also part of the effect of finding a new partner, since this effect contrasts 170 one's potential life satisfaction given a new partner with one's potential life satisfaction given no 171 new partner—and without a new partner, there is nobody to cohabit with. Avoiding control for potential mediators helps to identify the total effect of an event, which acknowledges that 172 173 experiencing an event may result in a chain of subsequent events.

174 Of course, researchers may only be interested in the direct effects of life events, which 175 calls for an approach that removes any effects mediated via other events. Such a procedure leads 176 to the second problem, however, because control for subsequent events can additionally introduce spurious associations via collider bias (Elwert & Winship, 2014; Rohrer, 2018; Wysocki et al., 177 178 2022). For example, Kettlewell et al. (2020) reported that "the unconditional positive effect of pregnancy on cognitive well-being was all but reversed once concurrent events (childbirth) were 179 180 accounted for" (p. 5). One should be careful not to interpret this as evidence that pregnancy had a 181 negative effect on life satisfaction. Pregnancy has a causal effect on subsequent childbirth; 182 pregnancy  $\rightarrow$  childbirth (see Figure S1 for an example causal graph). However, in the

183 unfortunate event of a miscarriage, no childbirth occurs. In the causal chain, suffering a 184 miscarriage (or not) is thus a second determinant of childbirth, miscarriage  $\rightarrow$  childbirth; and it 185 is likely associated on average with large negative effects on life satisfaction, miscarriage  $\rightarrow$  life satisfaction. Future childbirth is a so-called collider between its two causes, pregnancy  $\rightarrow$ 186 187 *childbirth ← miscarriage*, and statistical control for it will induce a spurious association via collider bias. Thus, in a model that controls for future childbirth, the coefficient of pregnancy will 188 be confounded by opening up a non-causal path via miscarriage (pregnancy  $\leftarrow \rightarrow$  miscarriage  $\rightarrow$ 189 190 *life satisfaction*) that was previously blocked. To put it another way, in purely statistical terms, 191 conditional on no child being born, the pregnancy coefficient contrasts those who were not pregnant (*pregnancy* == 0, *childbirth* == 0) with those who lost a pregnancy (*pregnancy* == 1,  $\frac{1}{2}$ ) 192 193 *childbirth* == 0). Based on these assumptions, we describe how we addressed collider bias in the 194 Analytical Strategy section below.

### 195 Prospective Longitudinal Data, Non-Linear Trajectories, and Control for Age-Related 196 Changes

197 In the study of life events, several recommendations have been put forward (Luhmann, 198 Orth, et al., 2014). First, using prospective longitudinal designs is critical when examining 199 selection and anticipation effects occurring before the event, as well as adaptation effects 200 occurring afterwards. Selection effects are present when the propensity to experience an event 201 depends on someone's person characteristics such as personality traits (Beck, 2019; Luhmann et al., 2013); such selection can induce common-cause confounding. Using a purely retrospective 202 203 design would forestall the investigation of anticipation effects and, in addition, introduce biases of recall and post-hoc narrative interpretation. Second, it is important to allow for non-linear and 204 205 discontinuous change trajectories. Modeling change in a purely linear (or polynomial) fashion 206 might mask the true form of the change trajectory. Third, event-related changes and normative or 207 age-related changes should be disentangled, which can be achieved through comparison with a 208 suitable control group that does not experience the event (Luhmann, Orth, et al., 2014). Without 209 such a group, developmental trends over the life span might be wrongly attributed to life events 210 happening around that age.

211 Current Study

212 In this study, we investigated the effects of a wide range of life events on life satisfaction, 213 including their repetition (e.g., second marriage, birth of a second child). We estimated models 214 for 14 life event types (see Table 1) using representative yearly panel data from Germany from 1984 to 2020. We strove to implement best practices with respect to modeling, and explicitly 215 216 took into account the potentially confounding effects of co-occurring life events. Further, we 217 allowed the effects of life events to vary by gender because effects sometimes differed between men and women in the previous literature (see Table S1). Following previous recommendations, 218 219 we estimated non-linear pre- and post-event trajectories (Luhmann, Orth, et al., 2014), and we 220 specified models of within-person change so that time-invariant background characteristics could 221 not confound findings (Allison, 2019; McNeish & Kelley, 2019; Rohrer & Murayama, 2023). 222 Our research was exploratory in the sense that we did not formulate substantive hypotheses for 223 each event but the methodology was preregistered (https://osf.io/kajrd).

To gauge the extent to which the effects of life events confound each other, and whether overcontrol bias could cause issues depending on the model specification, we contrasted models in which each event is considered individually with models that control for either all other life events, or only the preceding life events. In the first combined event model, we adopted a total control strategy and included other life events as control variables regardless of when they occurred (similar to Kettlewell et al., 2020). In the second combined event model, we adopted a

Table	1
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Event type	Available since wave	Analysis Sample	Total occurrence	1st occur.	2nd occur.	3rd occur.	4th occur.	5th occur.
Count based on biogra	phical informat	ion:						
New partnership	1984	Full	16,292	<u>8,625</u>	4,289	2,062	<u>916</u>	319
		Final	7,086	2,283	2,233	1,479	750	276
Cohabitation	1984	Full	10,666	<u>7,749</u>	2,053	<u>686</u>	143	35
		Final	4,373	2,353	1,296	567	123	34
Separation	1984	Full	13,476	<u>8,465</u>	<u>3,154</u>	1,248	455	116
		Final	5,801	2,862	1,690	809	334	81
Marriage	1984	Full	11,230	<u>8,135</u>	<u>2,543</u>	<u>489</u>	60	3
		Final	3,407	2,532	752	117	6	
Divorce	1984	Full	4,079	2,831	1,079	153	15	1
		Final	1,256	868	339	44	4	1
Childbirth	1985	Full	20,064	<u>8,125</u>	7,264	3,012	1,056	370
		Final	5,755	1,853	2,165	1,045	431	147
Count based on occurr	ence during pai	nel participat	tion:					
First job	1985	Full	9,980	<u>8,463</u>	1,320	171	22	4
		Final	4,296	3,542	643	95	13	3
Retirement	1985	Full	4,508	4,169	329	10		
		Final	642	602	40			
Unemployment	1985	Full	13,071	<u>10,859</u>	<u>1,807</u>	346	55	3
		Final	3,665	3,134	418	88	23	2
Child moved out	1985	Full	16,514	<u>11,198</u>	3,770	1,121	313	83
		Final	3,788	2,920	662	159	35	9
Death of partner	1985	Full	2,413	2,360	51	1	1	
		Final	333	325	8			
Death of father	2003	Full	3,852	<u>3,719</u>	128	5		
		Final	1,712	1,667	44	1		
Death of mother	2003	Full	3,886	<u>3,745</u>	137	4		
		Final	1,494	1,446	48			
Death of child	2007	Full	288	<u>279</u>	9			
		Final	103	103				

*Note*. For the first six event types shown here, biographical information allowed us to determine the biographically first, second, etc. occurrence of an event. For the remaining event types, the first, second, etc. occurrence of an event refers to the first, second, etc. observed occurrence while a respondent is a panel member. 6th and higher occurrences were observed for some events but are not depicted here. For all underlined occurrences, we considered these events separately in the coding of event dummies and in analyses.

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231 control strategy that aimed to strike a balance between two types of confounding: first, to reduce

undercontrol bias, we controlled for preceding life events, and second, to reduce the risk of

overcontrol bias, we refrained from controlling for events occurring in the future (including theiranticipation effects).

235

#### Method

#### 236 Sample and Procedure

We used data from the German Socio-Economic Panel (SOEP; Version 37<sup>1</sup>). The SOEP is 237 238 an ongoing household panel study initiated in 1984 which is representative of adults living in 239 private households in Germany (Goebel et al., 2019). Members of selected households aged 16 240 years or older were asked to participate in annual interviews. Households were initially chosen 241 using a multistage random sampling technique with regional clustering; later, some refreshment 242 samples were added to increase the sample size and maintain representativeness. Ethical permission was granted by the Scientific Advisory Board of DIW Berlin. 243 244 Four levels of exclusion criteria defined the different analysis samples (see Figure 1): First, 245 we excluded observations with missing data on life satisfaction (17,049 observations, 2,113 of 246 whom declined to answer), gender (13 observations), or birth year (3 observations), resulting in 247 the samples underlying the individual event models with maximal sample size (models I1). Second, we excluded observations prior to wave 2007 because we wanted to model the impact of 248 249 all life events jointly and the last event of interest to be added to the SOEP questionnaire (death 250 of a child) was included in 2007. Thus, samples underlying the individual event models were limited to years 2007-2020 (models I2). Third, in order to model all events jointly, we excluded 251 observations with missing data on any of the events. Together, application of these exclusion 252

- criteria yielded 40,121 respondents with 184,020 observations (53.84% women and 46.16%

<sup>&</sup>lt;sup>1</sup> After signing a contract on data distribution, the SOEP data are available for scientific use for free. More information can be found on https://www.diw.de/en/soep.

#### Figure 1

Respondent Flowchart



#### **Respondent Flowchart**

*Note.* Resp. = respondent; obs. = person-year observation. Dotted arrows represent exclusion of observations.

254	men <sup>2</sup> , $M_{age} = 42.02$ , $SD_{age} = 16.02$ ), resulting in the analysis samples underlying both combined
255	event models (models C1, models C2) as well as the individual event models based on the
256	combined event sample (models I3). This exclusion strategy is in line with previous studies but
257	extended to modeling multiple events jointly.
258	Additionally, for each life event we excluded observations from the non-event group (i.e.,
259	those who did not experience this event who served as a control group to account for normative
260	age effects) if they were not eligible to experience the event in the first place. For example, for
261	the event retirement, only individuals who were still part of the workforce (i.e., not yet retired)
262	were included. The criteria for inclusion in the non-event group are outlined below (see

263 Analytical Strategy).

#### 264 Measures

#### 265 *Life Satisfaction*

266 Life satisfaction was measured with a single item using an 11-point Likert scale: "In 267 conclusion, we would like to ask you about your satisfaction with your life in general. Please 268 answer on a scale from 0 to 10, where 0 means completely dissatisfied and 10 means completely 269 satisfied (see Figure S2 for the distribution of responses). How satisfied are you with your life, all 270 things considered?". Studies on the quality of such single-item measures indicate satisfactory 271 retest reliability (Lucas & Donnellan, 2012) and high criterion validity (Cheung & Lucas, 2014) 272 with longer scales such as the Satisfaction With Life Scale (Diener et al., 1985). 273 Life Events

We generated 14 different types of life events as dummy-coded variables (0 = "*Event did* not occur"; 1 = "*Event occurred*"; see Table 1).

<sup>&</sup>lt;sup>2</sup> The German language uses a single term, Geschlecht, to refer to sex and gender. In the SOEP, this variable was assessed in a binary manner for all waves included in our analyses.

276 Death of Father, Mother, Partner, or Child. Several events were based on respondents' 277 annual report of family-related changes (e.g., in 2014 "Has your family 278 situation changed since December 31, 2012? Please indicate if any of the following apply to you 279 and if so, when this change occurred."). Comparing monthly information from this item to the 280 month of the interview, we coded death of father ("Father deceased"), death of mother ("Mother 281 deceased"), death of partner ("My spouse / partner died"), and death of child ("Child deceased"). 282 Child Moved Out. The event child moved out was also drawn from this annual report of 283 family-related changes ("My son or daughter left the household"). 284 First Job. Information on respondents starting their first job was gathered from the 285 response option "I have entered employment for the first time in my life" to the item "Now a few 286 questions about your new position. What type of an employment change was that?" 287 Unemployment. We coded unemployment based on the item "Are you officially registered 288 as unemployed at the Employment Office ('Arbeitsamt')?" However, in this case we only coded an affirmative response as an event occurrence if it was preceded by two waves of not being 289 290 registered as unemployed. 291 **Retirement.** Retirement was coded based on the response option "Reaching retirement age / pension" to the question "How was this job terminated?" 292 293 **Childbirth.** Information on childbirth was obtained through a combination of yearly 294 questionnaire data and retrospective biographical information to trace and update the birth biography of each respondent ("biobirth" dataset; Schmitt & SOEP Group, 2020). This provided 295

297 New Partner, Cohabitation, Separation, Marriage, and Divorce. For these events, we 298 also relied on biographical spell data, which denote time periods with a defined start and end 299 ("biomarsy/m" and "biocouply/m" datasets; Hamjediers et al., 2022). For example, a marriage

the birth year and month for each child in order of the birth biography.

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spell would be defined by its start date (year and if available month of marriage) and its end date (which is set to the most recent wave if the person is still married). We used these spell data to code the biographically first and later occurrences of the events new partner, cohabitation, separation, marriage, and divorce. Compared to the usually employed coding of marital and relationship status events based on the annual report of family-related changes (see above), this had the advantage that we were able to differentiate repeated events based on their biographical sequence.

#### 307 Repeated Life Events

308 In the full sample, we examined multiple occurrences of the same event type. Table 1 309 shows how often each event occurred in total and repeatedly within respondents. Repeated 310 occurrences of the same event type were coded as separate events (e.g., first divorce, second 311 divorce) based on two considerations: First, to ensure sufficient sample sizes we included 312 repeated occurrences only as a separate event if at least 500 respondents reported it. Second, for substantive reasons, we were only interested in the first occurrence of first job, retirement, death 313 314 of mother, and death of father (where we assume that later occurrences are mostly the results of 315 inaccurate reporting). Including repeated occurrences of the 14 event types in this way resulted in 316 30 life events in total (see Table 1).

#### 317 Analytical Strategy

#### 318 Model Features

*Fixed Effects to Account for Time-Invariant Confounding.* To analyze the effects of life events on changes in life satisfaction, we used fixed effects models (Allison, 2019; Hamaker & Muthén, 2020; for similar analytic approaches using SOEP data, see Richter et al., 2019; Seifert et al., 2023), which are one of the standard approaches in economics and sociology to account for nested data. In longitudinal settings, fixed effects models exclusively analyze within-person

variance which is achieved in ordinary least squares (OLS) regression by including a cluster
affiliation dummy variable for each person. Variables that have no variation within persons are
dropped. Conceptually, this is similar to person-mean centering of all Level-1 variables in
multilevel models (Hoffman & Walters, 2022).

We see two main advantages of fixed effects models for our analytical purposes (McNeish & Kelley, 2019): First, they are not susceptible to bias from omitted time-invariant confounders. This means they "automatically" control for any unobserved, time-invariant background characteristics such as prior education, intelligence, or stable personality traits. Second, through straightforward OLS estimation, fixed effects models can deal with large amounts of timevarying predictors. Furthermore, fixed effects models rely on fewer assumptions (McNeish &

Kelley, 2019); for example, they do not assume that clusters are randomly sampled.

335 Discrete Time Dummy Variables to Allow for Nonlinear Pre- and Post-Event Effects. For 336 each life event, we coded time in relation to the event using discrete time dummy variables (with values 0 or 1; Perales, 2019). We used five dummies to model trajectories (see Table 2): Year 2 337 *before [event]* == 1 if the respondent experienced this event during the second year after the 338 339 current interview; Year 1 before [event] == 1 if the respondent experienced this event during the next year after the current interview; Year 1 after [event] == 1 if the respondent experienced this 340 event during the year before the current interview; Year 2 after [event] == 1 if the respondent 341 342 experienced this event between one and two years before the current interview; More than 2 *years after [event]* == 1 if the respondent experienced this event more than two years before the 343 344 current interview. Using these mutually exclusive dummy variables to represent time in relation to the event had the advantage that it did not impose a functional form on the pre- and post-event 345 346 change trajectories.

#### Table 2

Measure-	Event		ls Dun	t Marı 1my V	riage: 'ariab	les		ls Dum	t Dive my V	orce: ariabl	I	2nd Marriage: Dummy Variables								
Wave	Reported	-2	-1	+1	+2	≥ 3	-2	-1	+1	+2	≥ 3	-2	-1	+1	+2	≥ 3				
Individual E	vent Models,	Com	binec	l Ever	nt Mo	del with '	Total Co	ontro	l Strat	tegy (	Model C	1)								
1	no	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0				
2	1st Mar.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0				
3	no	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0				
4	no	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0				
5	1st Div.	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0				
6	no	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0				
7	2nd Mar.	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0				
8	no	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0				
9	no	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1				
10	no	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1				
Combined E	Event Model C	Contro	olling	for P	ast E	vents (Mo	odel C2)	with	n First	Divo	orce as the	e Focal	Even	t						
1	no	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0				
2	1st Mar.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0				
3	no	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0				
4	no	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0				
5	1st Div.	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0				
6	no	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0				
7	2nd Mar.	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0				
8	no	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0				
9	no	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0				
10	no	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0				

Dummy Variable Coding Schemes, Exemplarily for the Focal Event First Divorce and only First Marriage and Second Marriage Displayed out of the Nonfocal Events

*Note.* Mar. = marriage; Div. = divorce; -2 = year 2 before [event]; -1 = year 1 before [event]; 1 = year 1 after [event]; 2 = year 2 after [event];  $\geq 3 = 3$  or more years after [event]. The first eight rows show the coding scheme used to represent time in relation to the event for the individual event models and the combined event model with total control strategy (C1). The last eight rows show the coding scheme used for the combined event model controlling for past events (C2) where all nonfocal event dummies that came after the focal event (in this case, first divorce) were recoded to zero.

347

349 each life event. These models included two groups of observations: (1) all person-year

350 observations from respondents who ever experienced the event during panel participation, and (2)

351 the person-year observations from respondents who never experienced the specific event but 352 were in principle eligible to experience it. Thus, the combined event models differed in the size 353 of their analysis samples because different inclusion criteria of the respective non-event group 354 applied for different focal events. This ensured that respondents in the non-event group offered a 355 realistic counterfactual for the estimation of the effects of each life event as they could have 356 experienced it. For example, for second separation, the non-event group only included those who 357 have not reported the second separation before entering the survey or during panel participation 358 (the first separation did not matter for inclusion). For death of child, we only include parents in 359 the non-event group. The complete list of inclusion conditions based on eligibility to experience 360 the event as well as some additional explanations can be found in Table S2. The non-event group was relevant for the intercept estimation and also had the purpose to control for normative age 361 362 trends (Luhmann, Orth, et al., 2014), which is achieved by estimating slopes of age on the joint 363 analysis sample of event group and non-event group.

#### 364 **Resulting Models**

In total, we ran five models for each life event, three individual event models (referred to as
I1, I2, I3) and two combined event models (C1, C2; see Figure 1 and description below).

367 *Individual Event Models.* The formula for models of an individual event predicting life
368 satisfaction for a person *i* at time *t* reads:

369 
$$LS_{it} = \alpha_i + (\theta_{-2}E_{-2,it} + \theta_{-1}E_{-1,it} + \theta_1E_{1,it} + \theta_2E_{2,it} + \theta_{\geq 3}E_{\geq 3,it})female_i + \beta_1age_{ti}$$
  
370 
$$+ \beta_2age_{ti}^2 + \beta_3three\_years_{ti} + \epsilon_{it}$$

371  $\alpha_i$  represented the person fixed effect (i.e., the cluster-specific affiliation dummy). This 372 approach is equivalent to demeaning all variables by subtracting the person-mean from each 373 person-year observation, leaving only within-person variation (McNeish & Kelley, 2019). The 374 five  $E_{it}$  variables represented the dummy-coded predictors describing the temporal relation to the

19

375 event. These dummies were interacted with  $female_i$  (0 = male, 1 = female) to model gender 376 differences in the trajectories. Even though gender had no within-person variation in our sample and, thus, dropped out as a main effect in the fixed effects model, we could estimate its 377 378 interaction effect with the time-varying event dummies (conceptually equivalent to a cross-level 379 interaction in multilevel models; McNeish & Kelley, 2019). We added age and age-squared in order to account for trends in life satisfaction over the life span<sup>3</sup> (Fujita & Diener, 2005) and a 380 381 dummy variable for the first three years of survey participation to account for initial elevation 382 bias (Kratz & Brüderl, 2021; Shrout et al., 2018). We ran three individual event models per event 383 which progressively restricted the sample size until the third individual event model had the same sample size as the corresponding combined event models. Estimating the three individual event 384 models had the purpose to rule out that differences between the individual and combined event 385 386 model could result from differences in the sample composition (I3 and C1/C2 share the same 387 analysis sample), while also making use of the full data (I1) and checking whether inclusion 388 criteria affected conclusions (I1 vs. I2 vs. I3).

389 *Combined Event Models.* We first estimated a combined model for each focal event (FE) 390 that controls for the dummy variables of all other nonfocal events (NE) regardless of when they 391 occurred (C1, combined event model, total control strategy). Second, to address issues of 392 overcontrol bias described above, we estimated models that only control for preceding and 393 concurrent nonfocal events (relative to the occurrence of the focal event; C2, combined event model, controlling for past events). Control for preceding life events, even if they are 394 395 confounders, may still introduce spurious associations via collider bias by opening up more 396 complex confounding paths (Elwert & Winship, 2014). Depending on the precise underlying

<sup>&</sup>lt;sup>3</sup> In the preregistration, we stated that we plan to control for *person-mean centered* age and age-squared. However, for linear age trends, the person-mean centering makes no difference; and after person-mean centering, the squared age term would fail to capture curvilinear effects over the life span (and instead model curvilinear patterns relative to each respondent's mean age).

causal graph, control may both reduce and introduce bias (M-bias or butterfly bias; Thoemmes,
2015). Here, we nonetheless favor adjustment based on the assumption that the confounding
influence that is removed exceeds the more subtle bias that may be introduced. This seems a
plausible default assumption in the absence of a more precise understanding of the causal net
linking life events (which may also vary between individuals).

402 The resulting model formula can be restated as:

403 
$$LS_{it} = \alpha_i + \left(\theta_{-2}FE_{-2,it} + \theta_{-1}FE_{-1,it} + \theta_1FE_{1,it} + \theta_2FE_{2,it} + \theta_{\geq 3}FE_{\geq 3,it}\right)female_i$$

404 
$$+ \sum_{j=1}^{29} \left( \left( \theta_{-2,j} N E_{-2,j,it} + \theta_{-1,j} N E_{-1,j,it} + \theta_{1,j} N E_{1,j,it} + \theta_{2,j} N E_{2,j,it} \right) \right)$$

405 
$$+ \theta_{\geq 3,j} N E_{\geq 3,j,it} female_i + \beta_1 age_{ti} + \beta_2 age_{ti}^2 + \beta_3 three_years_{ti} + \epsilon_{it}$$

406 In the combined event models with total control strategy (C1), effects of the focal event 407 were controlled for the confounding influence of all other, nonfocal events, whose time dummy 408 variables were represented by the sum of the  $NE_{j,it}$  variables (of the 29 nonfocal events).

409 However, as described above, a more sensible control strategy involves controlling for life events that precede the focal event (which could potentially confound the association between the 410 411 focal event and well-being), but not for events occurring after the focal event (which could 412 potentially be consequences of the focal event). Thus, for the combined event models controlling 413 for past events (C2), we recoded all nonfocal event dummy variables such that they were zero for all nonfocal events following the focal event (i.e., events occurring in years after  $FE_{1,it} == 1$ ; 414 415 see Table 2). This offers a sensible compromise to estimate the causal effect of the focal life 416 event under the transparent assumption that it is only confounded with life satisfaction via preceding nonfocal life events. Based on our assumptions about the causal structure of potential 417 418 confounding through co-occurring life events, we believe that the combined event model

419 controlling for past events (C2) is the one better suited to estimate the effects of each focal life420 event on life satisfaction.

#### 421 Transparency and Openness

422 Analyses were conducted using Stata (Version 15.1; StataCorp, 2017). Because of the

423 clustered nature of the data we used panel-robust standard errors throughout (Brüderl & Ludwig,

424 2015). Plots were created in R (Version 4.2.1; R Core Team, 2023) using ggplot2 (Version 3.3.6;

425 Wickham et al., 2019). Analysis scripts can be found on the OSF (<u>https://osf.io/qdtb5/</u>). We used

- 426  $\alpha = .01$  as our main inference criterion.
- 427

#### Results

First, we present substantive results for all 30 life events of 14 event types based on our
preferred model, referred to as the combined event model controlling for past events (model C2;
see Figure 2). Second, we compare different models based on the same analysis samples to
investigate undercontrol and overcontrol bias, along with life event co-occurrence (see Figures 3,
4, S6, S7, & S8). Differences between the individual event models relying on samples with
varying inclusion criteria (models I1, I2, I3) are reported in the Supplemental Materials (Section
A; see also Figures S3, S4, & S5).

#### 435 Substantive Results for all Life Events

#### 436 New Partner

437 Finding a new romantic partner was associated with post-event increases in life satisfaction

438 (see Figure 2a,b,c,d). These increases were long lasting beyond three years for the first and

439 second occurrences. For later occurrences of finding a new partner, life satisfaction still increased

440 after the event but not consistently in a significant way.

#### Figure 2

Life Satisfaction Change Trajectories in the Combined Event Model Controlling for Past Events



Figure 2 (continued)



У z aa ab Men Women Men Women Men Women Men Women 0.75 0.75 0.75 0.75 Ourstandardized Effect Size (95% / 99% CI) Size (95% / 99% CI) -1.25 0.25 0.25 0.25 -0.25 -0.25 -0.25-0.75 -0.75 -0.75 -1.25 -1.25 -1.25 -1.75 -1.75 -1.75-1.75-2 -1 +1 +2>=3 -2 -1 +1 +2>=3 -2 -1 +1 +2>=3 -2 -1 +1 +2>=3 -2 -1 +1 +2>=3 -2 -1 +1 +2>=3 -2 -1 +1 +2>=3 -2 -1 +1 +2>=3 Time in relation to child moved out (2nd) Time in relation to child moved out (3rd) Time in relation to death of partner Time in relation to death of father ad ac Men Women Men Women 0.75 0.75 Unstandardized Effect Size (95% / 99% CI) Size (95% / 99% CI) -1.22 -1.25 0.25 -0.25 -0.75 -1.25 -1.75 -1.75-2 -1 +1 +2>=3 -2 -1 +1 +2>=3 -1 +1 +2>=3 -2 -1 +1 +2>=3 -2 Time in relation to death of mother Time in relation to death of child

Figure 2 (continued)

*Note.* The dashed line represents the approximate time of event occurrence. The plot panel background color indicates the grouping by life event types. Effects should be interpreted on the 11-point scale used for life satisfaction (SD = 1.80). Confidence intervals (both 95% and 99%) reflect the precision of the estimated effects.

#### 441 Cohabitation

Entering cohabitation with a partner was associated with gains in life satisfaction in the year afterwards (see Figure 2e,f,g). The positive effects persisted for men for the first and second occurrence and for women for the third occurrence, indicating long-lasting effects.

#### 445 Separation

Separation from a partner was related to post-event decreases in life satisfaction for both men and women (see Figure 2h,i,j). In addition, women's life satisfaction was already decreasing in the year before the event occurred for the first time. The post-event decreases were slightly more pronounced for the first event occurrence than for the second and third occurrences. For the second and third occurrences, this decrease in life satisfaction was only significant in the first year after separation.

#### 452 Marriage

Experiencing marriage for the first time was associated with significant increases in life satisfaction already starting before marriage and peaking in the year directly afterwards (see Figure 2k). Effects then declined in size but were still positive and significant at more than two years after the event suggesting a long-lasting influence. Effects were comparable in size for men and women. For second marriage, effects were smaller and only significant for women in the first year after the event (see Figure 2l). For third marriage, precision of the effect estimates was too low to reliably compare them to those of the first and second marriage (see Figure 2m).

#### 460 Divorce

Going through a divorce for the first time was associated with lower life satisfaction in the two years before the event for men (see Figure 2n). Women's life satisfaction was increased at three or more years afterwards suggesting slight long-term benefits of divorce. Effects for second divorce were estimated quite imprecisely (see Figures 2o). 465 Childbirth

In general, childbirth was associated with increases in life satisfaction before and after the event (see Figure 2p,q,r,s). These effects were larger (1) in the year directly after the event was first reported, (2) for mothers compared to fathers, and (3) for first childbirth compared to later childbirths. Positive effects of childbirth were long-lasting beyond three years only for first childbirth for women and for second childbirth for men.

471 First Job

472 There was no evidence that starting the first job was associated with changes in life473 satisfaction (see Figure 2t).

474 Retirement

475 Retirement was also not related to significant changes in life satisfaction (see Figure 2u).

#### 476 Unemployment

477 Life satisfaction declined in the first year after experiencing unemployment for the first

478 time (see Figure 2v). Women also experienced a significant decrease in the year before they

479 became unemployed and in the second year afterwards. For the second occurrence of

480 unemployment (see Figure 2w), effects were similar in size but estimated with lower precision.

481 Therefore, only women decreased significantly in the first year after becoming unemployed.

#### 482 Child Moved Out

483 Experiencing a child move out of the household was mostly unrelated to life satisfaction

484 (see Figure 2x,y,z). Only for the first occurrence, we found a significant negative effect for

485 women in the year before the event that was small in size.

486 **Death of Partner** 

The death of a spouse or partner was related to a large decrease in life satisfaction in the year when the event was first reported (see Figure 2aa). Women also experienced a significant decrease in the year before their partner's death.

490 Death of Father

We found no significant average effect of death of one's father on life satisfaction (seeFigure 2ab).

493 Death of Mother

For death of one's mother, we only found a single significant average decrease, for women, in the year in which the event was reported (see Figure 2ac).

496 Death of Child

497 Experiencing the death of a child was associated with a large decrease in life satisfaction in 498 the year after the event which was more pronounced for women (see Figure 2ad; only significant 499 at p < .05 for men). Due the relative rarity of the event, error bars were wide.

#### 500 Variation Across Combined Event Models: Potential Undercontrol and Overcontrol Bias

To investigate potential undercontrol and overcontrol bias, we now compare effects estimates across the individual event models (I3) and the two combined event models (models C1, total control strategy, and C2, controlling for past events). Differences in effects between the individual event model and the combined event model controlling for past events (I3 vs. C2) indicate potential undercontrol bias. Differences between the combined event model with total control strategy and the combined event model controlling for past events (C1 vs. C2) indicate potential overcontrol bias.

All things considered, we mostly found evidence for robustness of the individual event estimates (see Figure S6). High similarity between effect estimates (and also their precision) was especially evident for events unrelated to romantic relationships and family life (aggregated, 511 standardized effect size differences between models I3 and C2 indicating undercontrol bias: M =512 0.33, Mdn = 0.31 [IOR 0.12-0.46], SD = 0.26; aggregated, standardized effect size differences 513 between models C1 and C2 indicating overcontrol bias: M = 0.15, Mdn = 0.09 [IOR 0.03-0.20], 514 SD = 0.17; see Figures S4 & S7). Some of these events, notably retirement and death of a partner, 515 rarely co-occurred with other events, which may explain why confounding through other life events may not be a big concern here (see Figure S8). Unemployment co-occurred in a rather 516 517 unsystematic way with many types of events, which again may explain why other life events did 518 not introduce systematic confounding. First job mostly co-occurred with events typical in young 519 adulthood such as first partnership and first separation; confounding effects may thus operate in 520 different directions leaving no large bias on average.

521 In life events related to romantic relationships and fertility, however, confounding through 522 other events played a substantially larger role (undercontrol bias: M = 0.87, Mdn = 0.73 [IQR] 523 0.39-1.27], SD = 0.60; overcontrol bias: M = 0.36, Mdn = 0.16 [IOR 0.06-0.38], SD = 0.50; see 524 Figure S7). To illustrate how under- and overcontrol bias may play out, we will now discuss 525 differences in results across models for the events new partner, cohabitation, separation, 526 marriage, and childbirth. These events may play out in any order, and our estimates average 527 across the sequences that are in the actual data. However, these events often occur as a chain of 528 normative transitions, which can explain certain biases in the estimated average effects.

#### 529 New Partner

Results showed that effects of finding a new partner on life satisfaction changed in size depending on the control strategy (see Figures 3a,b & S6c,d). In general, individual event models indicated positive effects. These were estimated to be larger when controlling for preceding events than in the individual event models, in particular for men and for the second new partner (estimates in the year after finding a new partner, I3: b = 0.16, 99% CI [-0.01, 0.33]; C2: b =

#### Figure 3

Life Satisfaction Change Trajectories in the Individual (I3) and the two Combined Event Models (C1, C2)



*Note.* The dashed line represents the approximate time of event occurrence. Effects should be interpreted on the 11-point scale used for life satisfaction (SD = 1.80). Model I3 = individual event model based on the combined event sample; Model C1 = combined event model with total control strategy; Model C2 = combined event model controlling for past events. See Figure S6 for all life events. Confidence intervals (both 95% and 99%) reflect the precision of the estimated effects.

535 0.30, 99% CI [0.11, 0.50]). Finding a new partner mostly co-occurred with other relationship 536 events (see Figures 4a,b & S8c,d). Within two years, this event was frequently preceded by separation events. If we fail to account for the negative effects of such preceding separations, the 537 positive effects of the event new partner can be underestimated due to undercontrol bias. 538 539 New partners were not only frequently preceded by separations, but also succeeded by separations, which leads to concerns about overcontrol bias in the post-event trajectory. Two 540 541 years after the event, we found that life satisfaction increased to a larger extent in the combined 542 event model with total control strategy (e.g., women, first new partner, b = 0.37, 99% CI [0.15, (0.59]) than in the combined event model controlling for past events (first new partner, b = 0.28, 543 544 99% CI [0.07, 0.50]). The differences in magnitude here were, however, smaller than those 545 suggesting undercontrol bias (see Figure S7a,b,c,d). Thus, we may overestimate the positive effects of new partners if we "control away" the effects of subsequent separations and thus 546 547 effectively condition on relationship success.

#### 548 Cohabitation

549 We also found evidence for both undercontrol and overcontrol bias in the post-event effect 550 estimates for cohabitation, but this pattern was different than the one for a new partner (see 551 Figure S6e,f,g). Changes to life satisfaction were generally less positive if we controlled for other 552 events, indicating that undercontrol leads to an overestimation. Estimates were also mostly 553 smaller in the model with total control strategy than in the model controlling for past events, indicating that overcontrol may lead to underestimation. Considering the pattern of event co-554 555 occurrence (see Figure S8e,f), one explanation for this pattern is that without control for previous 556 life events, some of the positive effects of finding a new partner are attributed to cohabitation; 557 with control for future life events, some positive downstream effects due to marriage and childbirth are not attributed to cohabitation. 558

#### Figure 4

#### Co-occurrence of six Focal Event with the 29 Nonfocal Events

	(a)	Foo	cal e	ven	t: N	ew	part	ner	(1st	t), N	= 2	,283	3																				
At '-2' -		0	0	0	4	2	0	27	5	0	2	0	0	9	4	2	0	0	0	102	0	23	2	3	0	0	4	2	1	0			
At '-1' -		0	0	0	2	0	0	60	7	0	0	0	0	7	0	3	1	1	0	183	3	48	3	5	1	1	6	5	1	0			
At '+1' -	an:	0	0	0	41	4	2	91	4	2	2	0	0	10	2	4	0	0	0	170	1	57	9	13	2	1	0	12	8	0			
At '+2' -		36	0	0	191	13	3	518	54	6	32	7	0	7	4	27	5	1	0	125	0	49	9	4	1	1	0	6	1	0			
- 1	(b)	For	cal e	ven	t: N	lew	part	ner	(2n	d), /	V = 3	2,23	3																				
At '-2' -	144		0	0	19	7	1	243	11	3	4	0	0	8	0	6	3	2	1	80	2	33	6	16	4	1	5	8	6	2			
At '-1' -	36		0	0	9	2	0	595	49	8	3	0	0	11	4	2	6	2	2	107	1	42	6	17	4	1	7	15	7	0			
At '+1' -	0		1	0	40	32	1	87	42	3	3	4	0	39	4	7	2	2	0	85	4	64	9	23	7	3	1	17	11	0			
At '+2' -	0		28	0	171	105	7	67	398	21	33	15	đ	26	0	23	5	4	0	47	3	47	14	12	3	1	1	11	12	0			
1	(c)	Foo	al e	ven	t: S	epa	ratio	on (*	1st),	N =	= 2,8	362																					
At '-2' -	190	28	8	0	64	6	4		0	0	1	0	1	13	6	13	2	2	÷.	115	5	50	7	16	4	0	3	10	4	0			
4t '-1' -	442	64	14	2	74	35	6		0	0	0	0	0	32	6	12	9	4	3	163	1	57	10	19	2	1	1	7	6	0	Fr	eau	iency
At '+1' -	91	87	14	з	25	34	2		1	0	3	0	1	35	14	13	3	6	0	181	1	90	15	19	3	2	14	13	8	1		E f	10110y
At '+2' -	70	631	85	12	89	54	18		42	0	14	7	2	13	1	17	6	0	0	91	3	66	11	22	5	0	2	13	6	2			
	(d)	For	cal e	ven	t: S	epa	ratio	on (/	2nd)	). N	= 1,	690																				4	00
At '-2' -	35	136	29	12	32	18	12	200		0	1	0	0	21	8	9	8	5	0	44	2	23	8	9	1	1	3	9	9	1			000
At '-1' -	50	361	82	17	42	40	9	37		0	1	3	2	17	7	11	10	5	2	37	2	44	7	19	3	1	2	10	9	0		-	00
At '+1' -	4	42	63	19	13	26	13	1		2	3	1	0	18	5	6	3	5	2	35	2	57	10	27	5	2	12	17	10	1		c	2
At '+2' -	8	53	334	57	47	40	20	0		33	16	6	2	13	1	4	6	5	4	25	2	26	9	18	2	1	3	9	4	2			
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Nonfocal event

*Note.* The dashed line represents the approximate time of event occurrence. The Y-axis represents time in relation to the focal event (i.e., frequency of occurrence of each nonfocal event up to two years before and after the focal event occurred). N = overall event occurrence of the focal event in the respective final analysis sample. See Figure S8 for all life events.

#### 560 Separation

561 Another event where model comparisons suggested the presence of both undercontrol and overcontrol bias was separation (see Figures 3c,d, S6i, & S5h,i,j). For women, we found that, 562 563 controlling for past events, life satisfaction already significantly decreased in the year before first 564 separation (b = -0.18, 99% CI [-0.35, -0.02]), and then further decreased and remained lowered in the years afterwards (b = -0.38, 99% CI [-0.56, -0.21] and b = -0.20, 99% CI [-0.38, -0.01]). 565 566 These negative effects were underestimated in individual event models without control for cooccurring events (b = -0.08, 99% CI [-0.23, 0.08]; -0.28, 99% CI [-0.45, -0.11]; b = -0.11, 99%567 568 CI [-0.29, 0.06]). Men's estimates displayed a similar pattern but to a lesser extent. Considering 569 the potential for overcontrol bias, models that also controlled for future events generally 570 overestimated the negative long-term effects of separation. Thus, model comparisons indicated 571 that the magnitude and significance evaluation of effects of separation depended on the model 572 choice and indicated both undercontrol and overcontrol bias. 573 Looking at the overlap of nonfocal life events co-occurring with separation (see Figures 574 4c,d & S8j), we found that it was most frequently preceded and succeeded by new partner events. 575 Thus, the pattern of bias can be explained by the fact that some individuals who separate still

576 have elevated levels of life satisfaction due to a newly started relationship, if we fail to account

577 for this higher starting point, we underestimate the decline due to separation. Conversely, some

578 individuals who separate subsequently find a new partner which renders the long-term

579 consequences of separation less grave on average. If we erroneously control away the impact of

580 future life events (which would not have occurred without the separation), the resulting image is

too gloomy. Later occurrences (second and third separation) were frequently preceded by the

582 previous separation two years before. Cohabitation also happened somewhat frequently around

583 separation.

Because separation is part of a causal chain of related romantic relationship events, an appropriate control strategy is needed: The current results demonstrate that it is on the one hand necessary to control for preceding events. Otherwise, positive events in the past, mostly finding a new partner, produced upwardly biased change estimates. On the other hand, controlling for events following separation, often finding a new partner, introduced bias. In this case, estimates were downwardly biased because controlling for future events conditioned on those who remained single.

591 Marriage

592 We found evidence for both undercontrol and overcontrol bias through other events in 593 estimates of marriage which was comparable in size to bias for the new partner events. However, 594 the direction of average bias adjustment was flipped (see Figure S6k). For example, men's 595 increase in life satisfaction in the year after marriage was adjusted downward in the combined 596 event models suggesting the presence of undercontrol bias through preceding positive events. 597 Most frequently, first marriage was preceded by cohabitation (see Figure S8k) which also showed 598 generally positive effects on life satisfaction. These lagged effects of an earlier cohabitation 599 might be wrongly attributed to marriage in estimates of an individual event model. After 600 marriage, women's long-lasting positive changes in life-satisfaction appeared smaller when 601 controlling for future life events, which may be explained by downstream positive events such as 602 experiencing childbirth within two years after marriage (see Figure S8k).

603 Childbirth

The magnitude of effects on life satisfaction when experiencing childbirth also depended on the control strategy (see Figures 3e,f & S6r,s). Considering the birth of a first child in particular, failing to control for past life events mostly led to more positive effect estimates, whereas erroneously controlling for future life events led to less positive effect estimates. In contrast to later childbirths, first childbirth was frequently preceded *and* succeeded by positively
valenced relationship events such as cohabitation and marriage (see Figures 4e,f & S8r,s).
Therefore, bias adjustment for first childbirth reduced the size of the effect estimates and
increased it again somewhat when only adjusting for preceding events but not for succeeding
ones (as we argue is the most appropriate control strategy).

#### 613 Life Events with no Substantial Patterns of Bias

There were two events where bias was small and limited to either men or women: First, a small amount of undercontrol bias through the experience of other events was evident in men's reaction to first divorce (see Figure S6n). Second, effect estimates of child moved out were overall very similar across models. Only women experiencing the second occurrence of a child moving out differed in their estimates of post-event change depending on the control strategy (see Figure S6y).

Even though first job and unemployment relatively frequently co-occurred with other life events (see Figure S8t,v,w), differences between the individual event model based on the combined event sample and the combined event models were small indicating no substantial bias through other life events (see Figure S6t,v,w). For the remaining types of life events—retirement and the deaths of a partner, child, father, or mother—we found neither substantial patterns of event co-occurrence nor of undercontrol or overcontrol bias.

#### 626 Robustness Check

Lastly, we also ran models for the combined event models that did not include the events death of father, mother, and child, which allowed us to use a larger sample including more waves of the SOEP (as these events were added to the questionnaire only in later waves). These events did not show substantial undercontrol or overcontrol bias in the main analyses, which should render their omission unproblematic. Results based on this larger sample largely supported our 632 conclusions and can be found in the Supplemental Materials (see Figures S9 & S10).

633

#### Discussion

We analyzed the effects of life events on life satisfaction in a large German panel data set. 634 In contrast to the vast majority of previous studies (cf. Kettlewell et al., 2020), we investigated 635 636 multiple events simultaneously and evaluated the degree to which effect estimates for each event 637 were biased by the influence of events that preceded, or by control for events that followed. 638 Across all life events, we found more evidence for the robustness of individual event models than 639 for substantial shifts in coefficients depending on the control strategy. However, for the 640 interrelated life events in the romantic relationship and family formation domain, whether or not 641 other events were considered did influence the magnitude of effects as well as their statistical 642 significance.

#### 643 Are Effect Estimates of Life Events on Life Satisfaction Biased by Other Life Events?

644 The main goal of our study was to estimate life satisfaction change trajectories for each life event, minimizing potentially confounding effects of other life events. We used three models with 645 different control strategies to investigate the interdependence of life events which often occur in 646 647 close succession over the life span (Bleidorn et al., 2018; Hutteman et al., 2014). This clustering 648 of events is especially prominent in the "demographically dense" (Manning, 2020, p. 799) period 649 of young adulthood (see also Bleidorn & Schwaba, 2017; Roberts & Davis, 2016). Recent 650 methodological pieces have emphasized the importance of selecting appropriate sets of control 651 variables, including the omission of inappropriate controls, such as collider variables (Rohrer, 652 2018; VanderWeele, 2019; Wysocki et al., 2022).

For many life events, we found little evidence of bias induced by other life events, adding credence to previous studies that investigated within-person changes in well-being surrounding events using individual event models (e.g., Clark & Georgellis, 2013; Denissen et al., 2019). We

656 found robustness across models for first job, retirement, unemployment, children moving out of 657 the household, and the deaths of partner, father, mother, and child. This is in line with Kettlewell 658 et al. (2020) who found highly similar effects for the events unemployment, retirement, and death 659 of partner in the individual event model and a combined event model with total control strategy. 660 Our systematic investigation of event interdependence corroborates that it is possible in these cases to estimate effects that are unbiased by the occurrence of other events. Whereas the 661 662 deaths of father and mother did not, on average affect life satisfaction in our sample, we found 663 the largest overall changes for death of partner and death of child which were also the rarest 664 events (Asselmann & Specht, 2022; Moor & de Graaf, 2016; Reitz et al., 2022). These events 665 rarely co-occurred with other events.

For the much more frequent events first job and unemployment, it is less clear why no
interdependence with other events was found despite frequent co-occurrence. Other research has
shown severe declines in life satisfaction following unemployment that were in part moderated
by contextual factors such as re-employment expectations but also by having children (Lawes et
al., 2022b, 2022a; Lucas et al., 2004; Luhmann, Weiss, et al., 2014).

671 A different perspective emerged for events related to romantic relationships and 672 childbearing. Here, we found larger differences between individual and combined event models. 673 This was the case for new partner, separation, cohabitation, marriage, and childbirth. These types 674 of events are usually grouped non-randomly across the life span (i.e., clustered in early 675 adulthood; Hutteman et al., 2014) and causal relationships exist between them (see Bleidorn et 676 al., 2020). For example, both cohabitation and separation require finding a (new) partner 677 beforehand. Therefore, it makes sense that, for these events, we found more pronounced bias 678 through co-occurring events in predicting life satisfaction. The bias revealed by model 679 comparisons was relatively small in terms of the outcome (i.e., not larger than 13% of a SD in life

680 satisfaction) but sometimes quite substantial relative to the effects of interest (up to 68% of the 681 effect of the life event). While bias was not as large as to flip the direction of any effect in this particular study, this could happen with other combinations of life events. Moreover, in multiple 682 683 cases the choice of model also affected the significance evaluation of effects. Thus, bias through 684 event interdependence can influence how research on the influence of life events on life 685 satisfaction is conducted and interpreted. This bias also affects the evaluation of popular theories 686 such as set-point theory regarding adaptation over time after experiencing a life event (Diener et 687 al., 2006; Luhmann & Intelisano, 2018). If, for example, the long-term effects of first childbirth 688 are biased downwards in models that control for future life events (see Figure 3e), this affects the 689 evaluation of set-point theory. Controlling for other life events regardless of when they occurred 690 could, thus, lead to a systematic underestimation of the long-term effects. These patterns of bias 691 also matter for "bad is stronger than good" regarding the stronger effects of negative compared to 692 positive events (Baumeister et al., 2001). A valid estimation of the effects of positive and negative events is clearly a precondition for the evaluation of their relative impact. 693 694 Notably, patterns of bias varied between events. There was not, for example, a general 695 trend that adjusting for other events produced lower estimates or estimates closer to zero. 696 Following from that, we cannot assume that unadjusted, individual event models typically 697 provide an upper or lower bound for effects. Instead, we propose that the types of nonfocal events 698 that each combined event model typically controlled for and the nature of their effects on life 699 satisfaction determined the average direction of bias. Our analysis of the frequency of event co-700 occurrence provided initial evidence for this. For example, for separation, we found evidence for 701 both undercontrol and overcontrol bias in a pattern consistent between the first and second 702 occurrence. Estimates right before and right after the event were biased upward by confounding 703 through previous life events (for the most part positive events such as the beginning of the

relationship or cohabitation). Longer-term effects, however, were biased downward when
adjusting for future life events (mostly finding a new partner) indicating overcontrol bias when
adopting a total control strategy. This is consistent with a recent analysis of effects of separation
on well-being that showed more positive post-event trajectories if re-partnering occurred within a
year (Brüning, 2022).

709 Taken together, these results emphasize the need to carefully consider the appropriate 710 control strategy (Rohrer, 2018; Wysocki et al., 2022) when estimating effects of clustered events 711 related to relationships and fertility. The examination of event co-occurrence revealed meaningful 712 clusters and sequences of interrelated life events that often transpire in a normative chain of life 713 events in certain developmental phases (Hutteman et al., 2014). This contrasts Kettlewell et al. 714 (2020) who speculated that event co-occurrence was simply uncommon (without actually 715 examining it). Thus, when attempting to estimate the causal effect of a single life event on well-716 being we recommend controlling for other, preceding life events occurring in the previous two 717 years or earlier.

#### 718 How Does the Experience of Life Events Affect Life Satisfaction?

Our study also provided substantive insights into the trajectories of life satisfaction around important life events including more life events than previous studies and focusing on recent decades in our main models (2007-2020). The life events we analyzed can be grouped into three groups according to their effects on life satisfaction—positive, negative, and neutral or unclear.

#### 723 Positive Events

We found that the events new partner, cohabitation, marriage, and childbirth affected life satisfaction positively (see Clark et al., 2008; Clark & Georgellis, 2013). Finding a new partner was followed by post-event increases in life satisfaction (Kamp Dush & Amato, 2005; Soons et al., 2009). For women compared to men, we found more significant positive effects beyond two 728 years at later occurrences.

Cohabitation was similarly followed by increases in life satisfaction (Blekesaune, 2018;

730 Kamp Dush & Amato, 2005; Soons & Kalmijn, 2009; cf. Perelli-Harris et al., 2019). These

positive effects were stronger and longer lasting for men for the first two occurrences.

First marriage had positive effects on life satisfaction starting in the year before the event

and persisting afterwards (Clark & Georgellis, 2013; Qari, 2014; cf. Perelli-Harris et al., 2019).

Effects for second marriage, however, were only positive for women in the year after the event

735 was reported.

Childbirth had a positive effect on life satisfaction in the year before and the year after the
event (Anusic et al., 2014a; Krämer & Rodgers, 2020). Effects were, however, more pronounced
for women, especially for first childbirth (cf. Nelson-Coffey et al., 2019). Effects of later births
were overall less pronounced (Kohler et al., 2005).

#### 740 Negative Events

Conversely, separation, unemployment, death of partner, and death of child affected life satisfaction negatively. In line with previous studies, we found a short-term negative effect of separation on life satisfaction in the year after the event that was relatively similar for men and women (Brüning, 2022; Rhoades et al., 2011; Soons et al., 2009). For first separation, there was also evidence for a decrease in the second year after the event.

746 Unemployment was also followed by a decrease in life satisfaction (Clark & Georgellis,

2013; Lawes et al., 2022b; Luhmann, Weiss, et al., 2014). After one (men) or two years (women),

adaptation set in, possibly due to reemployment (cf. Lucas et al., 2004). As described in the

749 Supplemental Material (Section B), we found evidence for period effects (Bell & Jones, 2015).

750 Models based on all years from 1984 onwards indicated more severe effects than our final models

based on more recent data collected during times of low unemployment rates in Germany.

The deaths of partner or child both indicated very large decreases in life satisfaction in the year after the event (Anusic et al., 2014b; Asselmann & Specht, 2022; Moor & de Graaf, 2016; Reitz et al., 2022). Women also already experienced a smaller decrease in the year before partner bereavement. Adaptation occurred within a year after the death of a partner was first reported (Asselmann & Specht, 2022).

#### 757 Neutral or Unclear Events

758 For the remaining events, divorce, first job, retirement, child moved out, death of father, 759 and death of mother, no consistent effects were found. In contrast to previous research on divorce 760 (Clark & Georgellis, 2013; Denissen et al., 2019; van Scheppingen & Leopold, 2020), we found 761 minimal effects, that is, only a small long-term increase in women's life satisfaction. Two facts 762 might explain this: first, unlike other studies we analyzed divorce as a distinct event from 763 separation. Second, our model based on all available survey years showed the previously found 764 negative anticipation effect of divorce, too (see Supplemental Material, Section A). Possibly, the 765 normative meaning of divorce for evaluating one's life has diminished in recent decades.

#### 766 *Repeated Life Events*

Similar to Luhmann and Eid (2009), our results also demonstrate that the average effects of 767 life events can differ depending on how often people experience them over the life span. Going 768 769 beyond previous research, we included additional waves of data with more types of life events, 770 incorporated retrospective biographical information where possible (see Table 1), and controlled for the occurrence of other events. Again, findings differ across event types: for childbirth, we 771 772 see evidence for attenuated effects of later occurrences (especially in the full sample, see Figure 773 S3p,q,r,s), whereas this was generally not the case for partnership, separation, and cohabitation. 774 For other, luckily quite rare events such as bereavement or divorce we can currently not make reliable comparisons between repeated occurrences due to low precision at later occurrences. 775

#### 776 Limitations

Our study used nationally representative panel data and employed fixed effects models
(McNeish & Kelley, 2019) to exclusively analyze within-person variation addressing threats to
both external and internal validity. Still, several limitations applied that future research might
address.

781 First, the list of life events we analyzed is not set in stone. Our selection was based on both 782 theoretical deliberations (i.e., discrete status-changing transitions) and availability in the data 783 source. Other important life events that were not available in the SOEP might also matter for event interdependence. One example of a life event that is difficult to trace with panel data 784 785 because of higher drop-out rates is residential mobility. Still, in the domain of romantic 786 relationships and fertility where we found evidence for bias through other life events, the 787 selection is more or less complete and also goes beyond previous research by clearly 788 distinguishing repeated event occurrence based on biographical information.

789 Second, to interpret the effects of life events on life satisfaction as causal effects, we need 790 to assume that, beyond the included life events, no other time-varying confounds exist. For 791 example, if being promoted at work increases both the likelihood of entering a new relationship 792 and life satisfaction, this could bias the estimated trajectories for the life event new partner. At 793 the same time, fixed effects models allowed us to rule out the confounding influence of time-794 invariant background characteristics (similar to a propensity score matching design but also with 795 regard to unmeasured confounding; McNeish & Kelley, 2019), and to focus on within-person variance (similar to a person-mean centered variable in multilevel modeling; Hamaker & Muthén, 796 797 2020). We also controlled for aging (Luhmann, Orth, et al., 2014) and initial elevation bias 798 (Shrout et al., 2018). The problem of time-varying confounding is not unique to our study but 799 affects the literature on life events in general, at least within psychology. In contrast, studies from

economics frequently leverage so-called exogeneous variability to potentially achieve higher
internal validity (Grosz et al., 2023). For example, policy reforms may introduce variability into
retirement age which can in turn be used to identify the effects of retirement on well-being. Such
approaches come with their own assumptions, require sources of exogenous variation for each
life event to be investigated, and usually target narrower causal effects—thus, they do not
necessarily replace the within-person approach favored in psychological well-being research, but
they could be a valuable complement in future studies.

807 Third, we examined average trajectories of change, but the effects of life events of course
808 vary between individuals—for example, not every new relationship increases life satisfaction
809 equally. Other studies investigate such interindividual differences in change (Doré & Bolger,

810 2018), such as differences correlated with subjective event perception (Luhmann, Fassbender, et

811 al., 2021). The subjective perception of major life events in terms of dimensions such as

812 emotional significance or extraordinariness (Luhmann, Fassbender, et al., 2021), as well as

813 changes therein (Haehner et al., 2023), have been shown to relate to variation in well-being

814 during the experience of life events independent of other established covariates (e.g.,

personality). Such follow-up questions raise their own interesting inferential concerns (Rohrer &
Arslan, 2021)—for example, a correlation between a third variable and differences in effects does
not imply that the third variable causes those differences; scaling issues can introduce spurious
effect heterogeneity, and life satisfaction scales tend to be skewed—which should be tackled in
future studies.

Fourth, our findings only directly apply to the cultural and socio-economic context of Germany. Previous studies have found that there is cultural variation in the normative timing of life events related to personality maturation in young adulthood (Bleidorn et al., 2013). Still, we believe that the phenomenon of interdependent, co-occurring life events is relevant in all cultures with sequences of life events that occur clustered in the developmental phases of emerging and
young adulthood. Thus, patterns of confounding (and the risk of introducing overcontrol bias)
should be equally relevant.

827 Lastly, we relied on relatively normative life course narratives to interpret bias in the 828 context of common sequences of life events. But some supposedly less normative sequences 829 (e.g., marriage after childbirth, see Figure 2e,f) were just as common in the data, and the 830 estimated models considered event overlap regardless of normativeness. How much the societal 831 and subjectively perceived normativeness of individual event sequences matters for well-being 832 should be investigated in future research (e.g., extraordinariness vs. ordinariness dimension of the 833 Event Characteristics Questionnaire; Luhmann, Fassbender, et al., 2021). Paying more attention to specific sequences may also help overcome some of the "artificiality" of our approach of 834 835 isolating the effects of individual life events. For example, for an individual, the effects of 836 childbirth may appear inseparable from the effects of a previous marriage. Considering sequences 837 of events as treatment packages may allow to detect such effects, even if it poses its own 838 inferential challenges.

#### 839 Conclusion

We set out to comprehensively examine the effects of life events on life satisfaction while considering the potentially confounding influence of other preceding or succeeding life events. We did not find overwhelming evidence for such confounding in individual event models which is good news for the field of well-being research. Still, for life events in the domains of romantic relationships and fertility that are clustered and likely to follow a normative sequence, our model comparisons revealed meaningful patterns of bias shaped by event co-occurrence. Therefore, we believe that it is worth the effort for researchers interested in estimating effects of these life

- 847 events on well-being to carefully consider their control strategy and pay attention to confounding
- 848 bias through preceding nonfocal events.
- 849Open Science Statement
- 850 The study materials and analysis scripts used for this article can be accessed at
- 851 <u>https://osf.io/qdtb5/</u> and the preregistration at <u>https://osf.io/kajrd</u>. Data access is given to
- 852 researchers at <u>https://www.diw.de/en/soep</u>.

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