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# Effects of early institutionalization involving psychosocial deprivation on cognitive functioning 60 years later: Findings of the LifeStories project

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A R T I C L E I N F O

*Keywords:*
Early institutional care
Psychosocial deprivation
Neglect
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Lifespan
Dose–response effect

A B S T R A C T

*Background:* Institutionalization involving psychosocial deprivation affects child development negatively. However, there are few longitudinal studies, and no prospective study has yet examined the consequences of institutionalization in late adulthood.
*Objective:* Investigating effects of psychosocial deprivation on cognitive functioning 60 years later.
*Participants and setting:* A population-based survey of institutionalized infants and toddlers was conducted in Switzerland from 1958 to 1961 ($n = 387$; $M_{age} = 0.93$ years, $SD = 0.53$, 48 % female, 48 % Swiss nationality). In parallel, a comparison group of 399 family-raised children were assessed ($M_{age} = 0.85$ years, $SD = 0.50$, 46 % female, 100 % Swiss nationality). Six decades later, data on cognitive functioning were collected for 88 of the institutionalized group ($M_{age} = 62.63$ years, SD = 1.32), and 148 of the comparison group ($M_{age} = 65.06$, $SD = 1.32$).
*Methods:* Standardized tests were used: the Brunet-Lézine Developmental Test in early childhood and a short form of the Wechsler Adult Intelligence Scale in late adulthood.
*Results:* Formerly institutionalized individuals scored lower on cognitive functioning ($d = -0.67$, $p < .001$), with the greatest difference in working memory ($d = -0.78, p < .001$). Longer duration of institutionalization increased the risk of lower cognitive functioning, indicating a dose–response effect. Institutionalization's impact on adult cognitive functioning was mediated by early childhood developmental status but not by later educational attainment.
*Conclusions:* This study confirms the early experience hypothesis, indicating that early life conditions have lasting effects on human development, even into late adulthood.

## 1. Introduction

Adverse childhood experiences (ACEs), such as abuse, neglect, and family violence (McLaughlin & Sheridan, 2016), are a major

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public health problem affecting the lives of millions of children worldwide (Stoltenborgh et al., 2015). Numerous studies have shown that ACEs can have long-term negative effects on physical and mental health, limit overall life opportunities such as education, employment, and income, and are a risk factor for premature death (Brown et al., 2009; Felitti et al., 1998; Hughes et al., 2017; Metzler et al., 2017). The most common category of ACE reported to child protective services is neglect (Gilbert et al., 2009). Neglect is defined as the failure to meet children's basic needs (Dubowitz et al., 1993). Accurate prevalence data are difficult to obtain; however, a meta-analytic review estimated that neglect affects >15 % of children worldwide (Stoltenborgh et al., 2013). Despite the high prevalence of neglect, research on this issue is still very limited compared to other forms of ACE, such as physical and sexual abuse. This phenomenon is often referred to as "neglect of neglect" (Stoltenborgh et al., 2013). One reason for the dearth of studies on neglect is that the absence or failure to provide appropriate care is more difficult to identify than the direct, more visible acts of harm that characterize abuse (McSherry, 2007).

Different forms of neglect are distinguished, such as physical neglect, which is the lack of adequate nutrition, hygiene, and medical care, and psychosocial neglect, which is the lack of adequate emotional and cognitive stimulation (King et al., 2019). The risk that psychosocial neglect, also known as psychosocial deprivation, goes undetected is particularly high, because the consequences are not directly observable (Zeanah & King, 2022). But even though children's immediate physical safety is not endangered, psychosocial deprivation poses a serious developmental risk, as has been shown by strong evidence from children raised in institutional care (see meta-analysis by van IJzendoorn et al., 2020): Even in institutions where children's nutrition and hygiene is well cared for, institutional care is often characterized by high child–staff ratios, large group sizes, and rigid routines (Bakermans-Kranenburg et al., 2011). This setting makes it difficult to respond sensitively to each child's individual needs and to provide stimulating and comforting interactions that enable stable, individualized child–caregiver relationships to develop and support early learning (Zeanah & King, 2022). One of the most robust findings across studies on institutionalized children is that psychosocial deprivation experienced in early childhood is associated with substantial deficits in children's cognitive development (see meta-analyses by van IJzendoorn et al., 2008, 2020). However, to date, little is known about the long-term effects of psychosocial deprivation across the life course.

Some evidence suggests that although environmental enrichment following early institutionalization can lead to some degree of recovery, the increased risk of deficits in cognitive functioning persists over time (Humphreys et al., 2022). Major insights come from the landmark Bucharest Early Intervention Project (BEIP), in which children growing up in institutions involving deprivation were randomly assigned to high-quality foster care families. Children placed in foster care families had significantly better cognitive outcomes than children with prolonged institutional care. This intervention effect persisted into young adulthood. However, the individuals who received foster care still scored significantly lower on cognitive functioning than a comparison group of individuals who had never been institutionalized (Humphreys et al., 2022).

This finding is in line with the early experience hypothesis, which posits that experiences in the first years of life have a particularly lasting effect on development compared to experiences during later developmental periods (Zeanah et al., 2011). This hypothesis is explained by the fact that the brain exhibits particularly high plasticity during the first years of life and is therefore most susceptible to environmental influences (Knudsen et al., 2006; McLaughlin et al., 2018). The capacity of children's brains to adapt particularly fast to environmental experiences enables development and the learning of new skills. However, this high brain plasticity also means that during this period, children are most vulnerable to adverse experiences, and these can have damaging consequences for brain structure and function (McLaughlin et al., 2018). Although an enriching environment can still have a positive impact on development later in life, the changes in neurobiology and behavioral manifestations may require more time and effort due to decreased brain plasticity, and the level of cognitive capacity achievable may be reduced (Knudsen et al., 2006).

Evidence from studies on institutionalized children shows that the potential for recovery also depends on how long one has been exposed to psychosocial deprivation. This indicates a dose–response effect. For example, the English and Romanian Adoptees (ERA) study assessed the development of individuals adopted from severely depriving institutions in Romania into socioeconomically advantaged, supportive families in the UK and found that children who had experienced >6 months of psychosocial deprivation had a higher risk of persistent deficits in cognitive functioning. Rather surprisingly, however, this pattern was observed only up to adolescence; in young adulthood (age 22–25 years), individuals with a longer duration of institutionalization were able to catch up and no longer showed a higher risk of impaired cognitive functioning than those with shorter institutionalization and a group of non-deprived UK-adoptees (Sonuga-Barke et al., 2017). This change of pattern may be explained by the transactional model of gene–environment correlation: This model works from the assumption that children's cognitive development in the first years of life is determined mainly by the environmental conditions provided by their caregivers, whereas with increasing age the individual takes a more active role in shaping their own environment by selecting peer groups, activities, and learning experiences in line with their genetically influenced dispositions (Kendler & Baker, 2007; Tucker-Drob et al., 2013). Therefore, over the life course, early experiences may become less influential for an individual's cognitive functioning, whereas the impact of genetic factors grows when experiences become increasingly self-selected. This theory is supported by meta-analyses using twin and adoption studies, which have shown that the proportion of variance in cognitive functioning accounted for by heritability increases sharply over the life span, from <20 % in early childhood, up to 60 % to 80 % in adulthood (Briley & Tucker-Drob, 2013; Haworth et al., 2010; McGue et al., 1993; Plomin & Deary, 2015). The influence of genetic factors has been found to increase most strongly after the age of 20 years (McGue et al., 1993). However, studies on the impact of socioeconomic status have also shown that a person's genetic potential for cognitive development can only be fulfilled if appropriate opportunities for positive, cognitively stimulating learning experiences are available (Tucker-Drob et al., 2013). This means that limited access to education may suppress the genetic influences on cognitive functioning. Several studies have found that prolonged institutionalization is associated with a higher risk of school failure and less access to higher education (Ferguson & Wolkow, 2012; Jackson & Cameron, 2011; Montserrat & Casas, 2018). Thus, consistent with studies showing that additional years of education have a significant positive effect on cognitive functioning (see meta-analysis by Ritchie & Tucker-

Drob, 2018), lower opportunities for educational attainment may be a mediating factor that helps to explain why individuals who were institutionalized as children may not be able to realize their full genetic potential and have a higher risk of cognitive deficits in the long term.

Better understanding of the long-term effects of early psychosocial deprivation on cognitive functioning and the factors that may contribute to maintaining or mitigating this association requires longitudinal studies across the lifespan. To the best of our knowledge, no such long-term longitudinal studies have yet assessed the effect of psychosocial deprivation on later-life cognitive functioning.

### 1.1. The present study

We draw on data from the LifeStories project, a 60-year follow-up of individuals institutionalized as infants in Switzerland in the late 1950s (Lannen et al., 2021; Meierhofer & Keller, 1974). At that time, Switzerland had rather invasive child welfare practices, and many children of unmarried or underage mothers and children from migrant workers' families were placed in institutions, usually directly after birth (Businger & Ramsauer, 2019). Care practices at the time were typically characterized by strict routines and a lack of sensitive care and cognitive stimulation. However, the children's physical needs were well cared for in nutrition, hygiene, and medical care (Meierhofer & Keller, 1974). As a comparison group, we use data from the Zurich Longitudinal Studies (ZLS), which collected longitudinal data over 60 years from individuals who grew up in families at the same time in the same geographic region (Wehrle et al., 2021).

In a secondary analysis of the historical data collected in early childhood, we have previously shown that children in the institutionalized group had a significantly lower developmental status than those in the comparison group. Group differences were most prominent for language skills and social skills ($d = -1.21/-1.20$, $p < .001$). These effects cannot be explained by differences in baseline developmental risk, because no differences in birth weight could be found and because most children were institutionalized immediately after birth and thus were barely exposed to the family environment. Within the institutionalized group, interaction time, birth weight, frequency of family contact, and duration of institutionalization explained interindividual developmental differences (Sand et al., 2024). Here, we extend these analyses by linking the baseline data collected in early childhood with the data now collected in late adulthood, 60 years later. We address the following research questions:

**R1**. Does infant institutionalization predict cognitive functioning in late adulthood?

We hypothesized that individuals of the institutionalized group score significantly lower on cognitive functioning in late adulthood than those of the comparison group (H1a). We expected stronger effects for individuals with longer duration of institutionalization (H1b).

**R2**. What are potential mediating mechanisms explaining the association between infant institutionalization and cognitive functioning in late adulthood?

Working from our previous finding that institutionalized children in our sample had on average a significantly lower developmental status than those of the comparison group, we hypothesized that the developmental status assessed in early childhood would mediate the association between institutionalization and cognitive functioning in late adulthood (H2a). In addition, we considered education as an alternative explanatory factor and hypothesized that institutionalization would be associated with lower educational attainment, which in turn would predict cognitive functioning in late adulthood (H2b).

Presuming that educational opportunities would be particularly limited for those who had been in the institution for a longer duration, we further hypothesized that within the institutionalized group, the association between duration of institutionalization and cognitive functioning in late adulthood would be mediated by educational attainment (H2c).

## 2. Method

### 2.1. Study design

This study uses prospective data from both a group of individuals with a history of institutionalization and a comparison group of individuals raised in families. For the institutionalized group, data was collected in three waves.

The baseline data (wave 1) was collected between 1958 and 1961 from a population-based cohort of 431 children born between 1952 and 1959 that had been placed in infant and toddler care institutions in Zurich, Switzerland (Meierhofer and Keller, 1974). About half of the sample was of foreign nationality and their parents had a migrant worker status. In addition to illegitimate birth, parents' migrant worker status was the main reason for institutional placement at the time. To put this into context, it must be noted that at that time, the regulations for migrant workers in Switzerland were highly restrictive and discriminatory, focusing primarily on economic efficiency (D'Amato, 2012; Ricciardi et al., 2024). Both parents had to work full-time to be allowed to stay in the country. Consequently, in the absence of alternative care options, many migrant worker families had to place their children in institutions (Frigerio et al., 2014; Meierhofer & Keller, 1974).

Children's developmental status was assessed using standardized developmental tests. Additional data were obtained from administrative records and through observations (Meierhofer & Keller, 1974). About 10 years later, in early adolescence, a follow-up-assessment took place (wave 2): Between 1969 and 1971, 16 children were assessed as part of a preliminary study (1969–1971). Further, 142 children took part in the main follow-up study between 1971 and 1973 (Meierhofer & Hüttenmoser, 1975; Meyer-Schell, 1971). Between 2019 and 2023, all individuals of the original study cohort were searched through population registries. Those individuals who were located (83 % of the original cohort, $n = 358$) and were eligible for contact (for more details on the eligibility criteria see Fig. 1 and Lannen et al. (2021)) were then invited to participate in the 60-year follow-up assessment of health and well-being (wave 3). At wave 3, data was collected with a multimethod approach (Lannen et al., 2021). Data on cognitive functioning used for the present analyses were collected as part of a comprehensive psychological assessment. Fig. 1 shows a detailed flowchart of the institutionalized group sample over time. For the present analyses, we primarily focus on the data collected for waves 1 and 3, because they involved the same assessment instruments as in the comparison group and therefore allow better comparability. Data from wave 2 was only used for selected demographic information and for data on duration of institutionalization.

As a comparison group, we use data from a community sample of 399 children with Swiss nationality that were born in an overlapping period, between 1954 and 1961, and grew up in families in the same geographic region. The sample was representative of the Zurich population in parental occupation (Fischer, 1960). These children were continuously assessed between 0 and 18 years as part of the Zurich Longitudinal Studies (ZLS). Between 2019 and 2022, they were also located through population registries and invited for a follow-up-assessment in late adulthood (Wehrle et al., 2021).

### 2.2. Ethics

For the institutionalized group, an independent ethics expert reviewed the historical study components using primary data, reports, and publications. The review concluded that the assessments conducted at that time align with today's ethical standards (Brauer, 2019). In addition, for wave 3, the study procedure was evaluated and approved by the Ethics Committee of the Faculty of Philosophy at the University of Zurich (Approval Number 19.4.7). Further details on ethical considerations can be found in Lannen et al. (2022). For the comparison group, the study procedure was reviewed and approved by the Ethics Committee of the Canton of Zurich, Switzerland (Basec-Nr. 2018–00686). Details are provided in Wehrle et al. (2021).

### 2.3. Sample

Information on eligibility criteria can be found in Fig. 1. Descriptives of both groups are shown in Table 1.

### 2.4. Missing data

To choose appropriate methods for handling missing data, we first conducted Little's multivariate test of missing completely at random (MCAR; Little, 1988) using all variables included in the analysis to identify missing data patterns. As variables such as duration of institutionalization were only available for the institutionalized group, we ran the test separately for both groups. Little's test

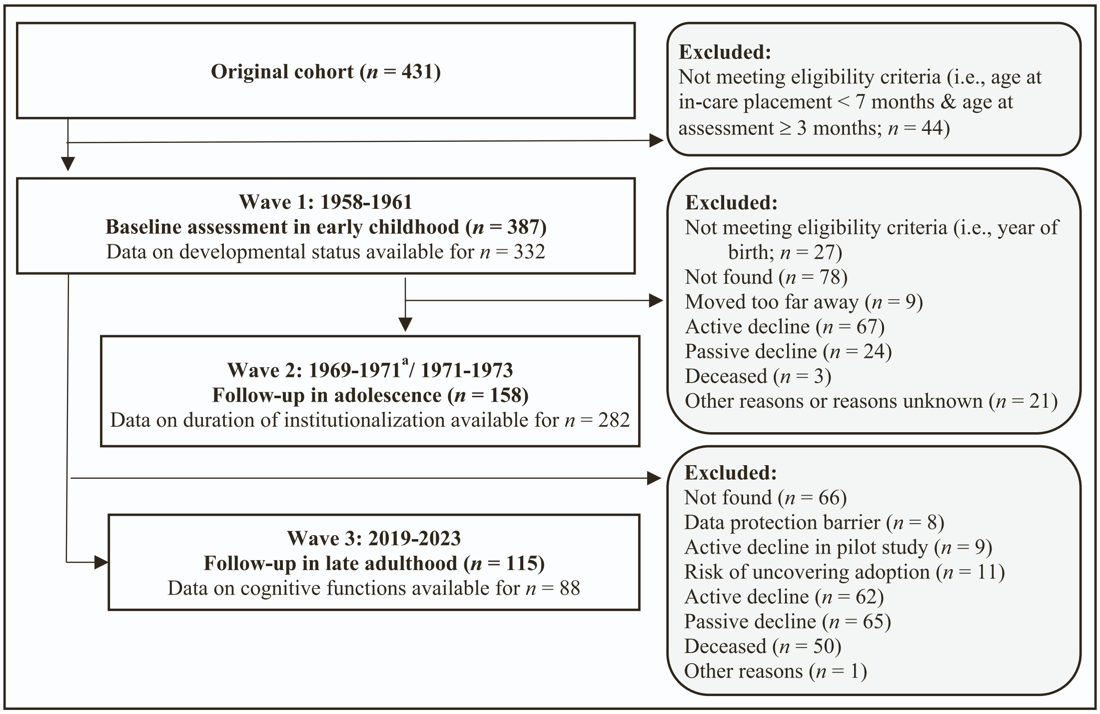


**Fig. 1.** Flowchart of the Institutionalized Group
*Note.* [a]Preliminary follow-up study with $n = 16$.

**Table 1**
Descriptive statistics and mean differences.

| Variable | n | | M (SD) | | Mean differences | |
|---|---|---|---|---|---|---|
| | CG | IG | CG | IG | Cohen's *d* | *p* |
| Sex (Female)[1] | 399 | 387 | 46 % | 48 % | 0.04 | .54 |
| Nationality (Swiss)[2] | 399 | 381 | 100 % | 48 % | −1.71 | <.001 |
| Birth weight | 152 | 220 | 3371.87 (459.03) | 3307.00 (504.44) | −0.14 | .19 |
| Age at assessment: wave 1 | 332 | 332 | 0.85 (0.50) | 0.93 (0.53) | 0.14 | .08 |
| BL: developmental status | 332 | 332 | 100.61 (8.27) | 84.79 (10.98) | −1.63 | <.001 |
| Duration of institutionalization (≥ 2.55 years)[3] | | 282 | | 50 % | | |
| Age at assessment: wave 3 | 150 | 88 | 65.06 (1.32) | 62.63 (1.32) | −1.84 | <.001 |
| Educational attainment | 150 | 88 | 13.81 (2.40) | 13.27 (2.61) | −0.22 | .11 |
| WAIS: average score | 142 | 86 | 11.07 (1.80) | 9.89 (1.65) | −0.67 | <.001 |
| WAIS: verbal comprehension | 148 | 88 | 10.74 (2.61) | 10.26 (2.25) | −0.19 | .15 |
| WAIS: perceptual reasoning | 148 | 88 | 11.48 (2.60) | 10.09 (2.56) | −0.54 | <.001 |
| WAIS: working memory | 145 | 86 | 10.81 (2.62) | 8.76 (2.67) | −0.78 | <.001 |
| WAIS: processing speed | 144 | 87 | 11.26 (2.41) | 10.47 (2.28) | −0.34 | <.05 |

*Note.* CG = comparison group; IG = institutionalized group; BL = Brunet-Lézine Developmental Test; WAIS = Wechsler Adult Intelligence Scale.
[1] Dichotomous variable with “0 = male and 1 = female”.
[2] Dichotomous variable with “0 = foreign nationality and 1 = Swiss nationality”.
[3] Dichotomous variable with “0 = institutionalized for <2.55 years and 1 = institutionalized for 2.55 years and more”.

indicates no significant violation of MCAR for both the institutionalized group ($\chi^2(94, n = 387) = 106.37, p = .18$) and the comparison group ($\chi^2(38, n = 399) = 46.15, p = .17$). To further inspect the data and examine the selectivity of attrition, we additionally ran multiple logistic regressions for both groups. The results are provided in Table 2 together with an overview of the sample characteristics.

As Table 2 shows, none of the predictors included in the multivariate analysis were significantly associated with dropout at wave 3 in either of the groups studied here. However, we found that in the institutionalized group, individuals who are not of Swiss nationality were marginally significantly less likely to participate in the follow-up assessment. This can be attributed to the proportion of children of migrant workers and the fact that many of them returned to their country of origin, where it was more difficult to locate people than within Switzerland. Altogether, apart from the slightly higher retention rate for individuals with Swiss nationality, the results of neither analysis provide any evidence that the data are not MCAR. We therefore included nationality as a control variable in all subsequent analyses and used the full information maximum likelihood (FIML) estimation approach to address missing data, assuming that it would most likely provide unbiased results. For comparison, in the sense of a sensitivity analysis, the results of the complete-case analyses can be found in the appendix (Table A.1).

### 2.5. Measures

#### 2.5.1. Demographic variables

Information on nationality, sex assigned at birth, and birth weight were derived from administrative records of the institutions at wave 1. Some of these data were also collected in the follow-up assessments. This allowed us to compare the information for validation

**Table 2**
Distribution of baseline characteristics based on wave 3 participation status with results of logistic regression.

| Group | Characteristics | Wave 3 | | | |
|---|---|---|---|---|---|
| | | Nonparticipant *M (SD)/%* | Participant[1] *M (SD)/%* | *B* | *p* |
| IG | Sex (Female)[2] | 49 % | 45 % | −0.00 | 0.991 |
| | Developmental status | 84.88 (11.03) | 84.49 (10.87) | −0.01 | 0.505 |
| | Nationality (Swiss)[3] | 44 % | 60 % | 0.60 | 0.073 |
| | Birth weight | 3327.71 (527.35) | 3259.7 (447.89) | −0.00 | 0.283 |
| | Duration of institutionalization (≥ 2.55 y.)[4] | 49 % | 52 % | 0.21 | 0.536 |
| CG | Sex (Female)[2] | 46 % | 46 % | −18.19 | 0.996 |
| | Developmental status | 99.37 (8.21) | 102.48 (8.02) | 0.10 | 0.332 |
| | Birth weight | 3200 (282.84) | 3376 (459.55) | 0.00 | 0.786 |

*Note.* IG = institutionalized group, CG = comparison group.
[1] Because cognitive functioning was used as outcome measure in all following analyses, individuals who participated in other parts of the wave 3 assessment but had no data for cognitive functioning are not considered as participants here. Thus, here, $n_{IG/CG} = 88/150$ are counted as participants.
[2] Dichotomous variable with “0 = male and 1 = female”.
[3] Dichotomous variable with “0 = foreign nationality and 1 = Swiss nationality”.
[4] Dichotomous variable with “0 = institutionalized for <2.55 years and 1 = institutionalized for 2.55 years and more”, using the median of duration of institutionalization as cut-off.

purposes and to supplement the wave 1 data in case of missing data. For the comparison group, information on the demographic variables was collected in early childhood from interviews with the parents, usually the mothers.

#### 2.5.2. Developmental status in early childhood

A standardized developmental test for children aged 1 to 30 months, the *Échelle de développement psychomoteur de la première enfance* by Brunet and Lézine (1951), was used at wave 1. The test assesses four developmental domains: gross motor skills, fine motor skills, language skills, and social skills. Across these four domains, an age-normed developmental quotient (DQ) is computed that indicates a child's overall developmental status. In a normative sample of over 700 children, the mean DQ ranged from 98 to 106, depending on age group (Rennen-Allhoff & Allhoff, 1987). In our study, test data was available for 332 children in the institutionalized group. Whereas the children in the institutionalized group were only tested once, the children in the comparison group were tested multiple times between the ages of 2 months and 2 years. For better comparability, we matched each child in the institutionalized group with a child in the comparison group for age at assessment and sex assigned at birth, see paragraph on analysis strategy for details.

#### 2.5.3. Cognitive functioning in late adulthood

Cognitive functioning was assessed at wave 3 using a short form of the German version of the Wechsler Adult Intelligence Scale IV (WAIS-IV; Petermann & Petermann, 2013). The full version of the WAIS contains ten core subtests grouped into four indexes: The Verbal Comprehension Index (VCI), the Perceptual Reasoning Index (PRI), the Working Memory Index (WMI), and the Processing Speed Index (PSI). When short forms are applied, it is recommended to use at least one test from each index to obtain a more comprehensive picture of the various domains of cognitive functioning (Jiménez Bascuñán et al., 2020). Accordingly, we used Similarities as a proxy of the VCI, Block Design as a proxy of the PRI, Digit Span as a proxy of the WMI and Coding as a proxy of the PSI. The internal consistency of these four subtests ranges between .84 and .95, and the test–retest reliability lies between .71 and .88 (Petermann & Petermann, 2013). Test data was available for 88 individuals of the institutionalized sample and 148 of the comparison group.

Because participants of the comparison group were on average slightly older when tested in adulthood (see Table 1), we used age-corrected scaled scores instead of raw scores.

#### 2.5.4. Educational attainment

At wave 3, the number of years of formal education was assessed by self-report. For a standardized procedure on how to deal with such characteristics as part-time studies and grade repetition, we used the approach by Thomann et al. (2018). Accordingly, the maximum number of possible years of education was defined as 20 years. For the comparison group, educational attainment was additionally assessed in line with the Swiss Household Panel (Voorpostel et al., 2022), where the highest level of education reached was operationalized on a scale from 0 (= compulsory school not finished) to 16 (= PhD), and both measures correlated with $r = .84$ ($p < .001$), indicating a high validity.

#### 2.5.5. Duration of institutionalization

As part of the recruitment process for the follow-up assessment in early adolescence, information on placement changes from birth until the time of wave 2 recruitment, which took place between 1969 and 1973, was documented for 282 participants. To capture the total duration of institutionalization, we added up all periods during which the child was placed in an institution: all periods that this individual did not spend in family-based care, regardless of whether it was the biological family, or a foster or adoptive family. Duration of institutionalization in our sample showed a large variance, with a range of over 15 years. On average children were institutionalized for 4.3 years ($SD = 4.0$; skewness = 1.3; kurtosis = 0.7), before they permanently returned to their biological family or lived with foster or adoptive families. Recovery from psychosocial deprivation is thought to be more difficult when children are exposed to it for a longer duration (van Ijzendoorn et al., 2020). However, the evidence available to date does not enable conclusions to be drawn about a specific threshold for recovery. For example, Dennis (1973) postulated that a duration of institutionalization of up to 2 years might be reversible, whereas in the ERA study, a duration of institutionalization of >6 months was shown to increase the risk of persistent deficits (Kreppner et al., 2007). Because only seven individuals in our sample had been placed in institutions for <6 months, we decided to take a data-driven approach to addressing hypotheses H1b and H2b and subdivided the institutionalized individuals into two groups using the median of duration of institutionalization as cut-off ($Md = 2.55$ years).

### 2.6. Analysis strategy

#### 2.6.1. Matching procedure

Because individuals of the comparison group were tested multiple times in early childhood, they had multiple values for the Brunet-Lézine developmental test, whereas children in the institutionalized group were only tested once at wave 1. We therefore matched it with the data of the institutionalized group by age at assessment at wave 1 and sex assigned at birth using 1:1 nearest-neighbor matching without replacement using the R-package MatchIt (Ho et al., 2011). In this method, for each individual of the institutionalized group, one individual of the comparison group is chosen as a matching partner that is closest in terms of covariate values. This process was repeated until each individual from the comparison group was uniquely assigned to one individual from the institutionalized group. This resulted in a sample of 332 individuals in each of the institutionalized and the comparison groups. Another 55 individuals of the institutionalized group did not have test data from wave 1, either because the test data from that time could not be recovered or because they were slightly older at the time of assessment (> 30 months) and thus, the Brunet-Lézine developmental test was not used as it was no longer age-appropriate. We thus included them in the final sample for the analysis together with the remaining individuals of the comparison group without further matching. As Table 1 shows, this final sample of 387 in the institutionalized group and 399 in the comparison group was well-balanced in all demographic characteristics included except for nationality. This is because Swiss nationality was an eligibility criterion for the comparison group and an additional rationale for including nationality as a control variable in all subsequent analyses.

### 2.6.2. Analyses related to Research Question 1

Hypotheses H1a and H1b were tested with structural equation models. To address H1a, we used the dichotomous variable of institutional placement as independent variable (with 1 for the institutionalized group and 0 for the comparison group). This model is referred to as Model 1a. In Model 1b, used to address H1b, we subdivided the institutionalized group at the median of duration of institutionalization ($Md = 2.55$ years). We then dummy-coded the group variable using the comparison group as reference category. Accordingly, two dummy variables were included as independent variables in the model, (a) the dummy variable identifying individuals institutionalized for <2.55 years and (b) the dummy variable identifying those institutionalized for 2.55 years or longer.

We included cognitive functioning as outcome in both models. For this purpose, we created a composite score by averaging the four subtests of the WAIS. McDonald's omega of 0.67 indicated a rather low internal consistency. However, this should not be seen as a limitation; instead, it confirms the theoretical assumption that the four subtests used as proxies for the four indices of the WAIS measure different domains of cognitive functioning. In contrast, very high correlations among the four subtests would have indicated that they were not measuring distinct aspects of the construct and thus indicated redundancy (Stadler et al., 2021). Moreover, previous research has shown that ACEs do not affect all domains of cognitive functioning equally (see meta-analysis by Masson et al., 2015). To capture these differences in more detail, we ran additional analyses where we included all four domains of cognitive functioning as separate outcome variables in the model. To take measurement errors into account, we specified each outcome domain as a single-indicator latent variable fixing the error variance of each factor according to the test–retest reliability reported in the manual (Petermann & Petermann, 2013).

We controlled for nationality as described above. In addition, we included sex and birth weight as control variables, because previous studies have shown that these might predict cognitive functioning over the lifespan (Flensborg-Madsen & Mortensen, 2017; Maitland et al., 2000; Raikkonen et al., 2013; Zhang & Zhang, 2022). Fig. 2 illustrates the basic conceptual models.

### 2.6.3. Analyses related to Research Question 2

To test hypotheses H2a and H2b, we constructed a two-mediator parallel multiple mediator model including developmental status and educational attainment as mediators (Model 2a; Fig. 3). This model allows comparisons between indirect effects operating through different mediator variables (Coutts & Hayes, 2022; Preacher & Hayes, 2008). Analogously to Model 1a, we included institutional placement as dichotomous variable and controlled for nationality, birth weight, and sex.

For hypothesis H2c, assessing whether educational attainment mediated the association between duration of institutionalization and the different domains of cognitive functioning, we only used data for the institutionalized group. We specified a simple mediator model with educational attainment as a mediator variable (Model 2b). As in the previous models, we controlled for nationality, birth weight, and sex. In addition, we included children's developmental status as control variable. The conceptual model is shown in Fig. 4.

We used R (version 4.2.1) for all statistical analyses (R Core Team, 2020). Structural equation models were conducted using the *lavaan* R package (Rosseel, 2012) with FIML to account for missing data, and robust standard errors to account for non-normality. Mediation was tested by computing bias-corrected bootstrapped 95 % confidence intervals (CI) using 10,000 data resamples.

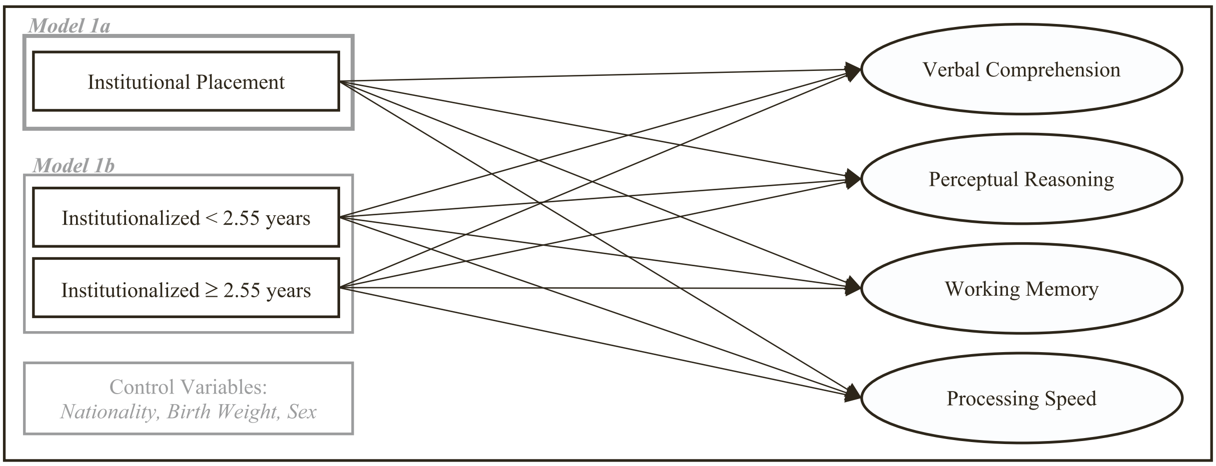


**Fig. 2.** Basic conceptual model for Model 1a (H1a) and Model 1b (H1b).

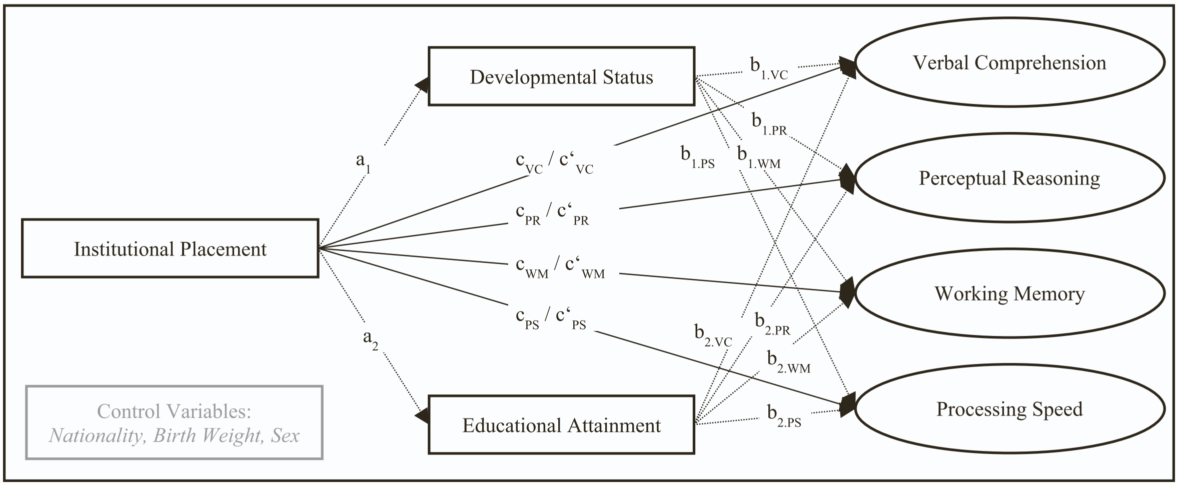


**Fig. 3.** Basic conceptual model for Model 2a (H2a & H2b).

## 3. Results

Sample characteristics of both groups are shown in Table 1. Bivariate correlations between the key variables included in the subsequent analyses are presented in Table 3.

### 3.1. *Group differences in cognitive functioning in late adulthood*

In Model 1a, comparing all individuals in the institutionalized group irrespective of duration of institutionalization with those in the comparison group, we found substantial group differences with small-to-medium effect sizes: When birth weight, sex, and nationality were controlled for, the individuals institutionalized as infants had a significantly lower average score for cognitive functioning than those in the comparison group. This was also confirmed in the model using the various domains of cognitive functioning as outcome variables, with the strongest group effect for working memory (Fig. 5, Table 4).

Model 1b showed that the differences from the comparison group were substantially larger for the group who had been institutionalized for 2.55 years and longer (Table 4, Fig. 6). This was evident both for the average score and across the four domains of cognitive functioning. The effects were all of medium size except for verbal comprehension, where only a small effect was found. For the group that underwent duration of institutionalization $<$2.55 years, we found only small effect sizes across all domains of cognitive functioning. In addition, the group effect was no longer significant for verbal comprehension, and only marginally significant for perceptual reasoning.

Regarding the control variables, Model 1a and 1b (Table 4) showed that females scored lower in the test of cognitive functioning with a small effect, evident both for the average score and the scores of verbal comprehension and perceptual reasoning. There was also a significant negative effect of nationality, with small effect sizes for the average score and verbal comprehension, and a medium effect for processing speed, indicating that individuals with Swiss nationality scored lower than individuals with foreign nationality. Across

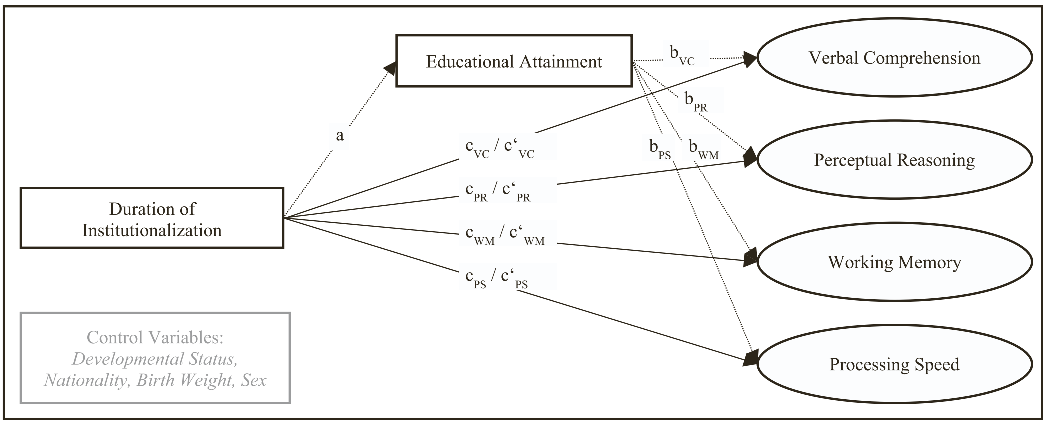


**Fig. 4.** Basic conceptual model for Model 2b (H2c).

**Table 3**
Bivariate correlations.

| Variable | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Institutional placement (IG)[1] | – | | | | | | | | | |
| 2 | Sex (Female)[2] | 0.02 | – | | | | | | | | |
| 3 | Nationality (Swiss)[3] | −0.60*** | −0.07† | – | | | | | | | |
| 4 | Birth weight | −0.07 | −0.10† | 0.01 | – | | | | | | |
| 5 | Educational attainment | −0.10 | −0.32*** | 0.08 | 0.05 | – | | | | | |
| 6 | BL: Developmental status | −0.63*** | 0.05 | 0.37*** | 0.12* | 0.08 | – | | | | |
| 7 | WAIS: Average score | −0.31*** | −0.13† | 0.08 | 0.03 | 0.48*** | 0.34*** | – | | | |
| 8 | WAIS: Verbal comprehension | −0.09 | −0.15* | −0.03 | −0.01 | 0.43*** | 0.10 | 0.68*** | – | | |
| 9 | WAIS: Perceptual reasoning | −0.25*** | −0.13* | 0.15* | 0.06 | 0.36*** | 0.30*** | 0.69*** | 0.31*** | – | |
| 10 | WAIS: Working memory | −0.35*** | −0.09 | 0.19** | 0.05 | 0.24*** | 0.30*** | 0.72*** | 0.31*** | 0.27*** | – |
| 11 | WAIS: Processing speed | −0.16* | 0.02 | −0.07 | 0.02 | 0.35*** | 0.24*** | 0.75*** | 0.37*** | 0.38*** | 0.41*** |

*Note.* BL = Brunet-Lézine Developmental Test. WAIS = Wechsler Adult Intelligence Test.
[1] Dichotomous variable with "0 = comparison group (CG) and 1 = institutionalized group (IG)".
[2] Dichotomous variable with "0 = male and 1 = female".
[3] Dichotomous variable with "0 = foreign nationality and 1 = Swiss nationality".
† $p < .10$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

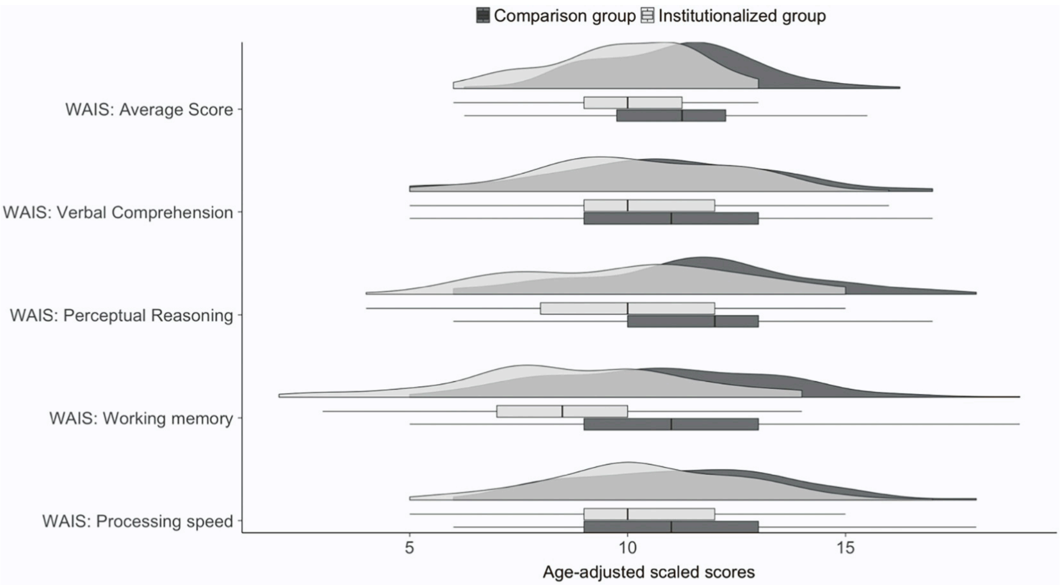


**Fig. 5.** Grouped plots for cognitive functioning at Wave 3.

all domains of cognitive functioning, no significant associations with birth weight were found.

### 3.2. Potential underlying mechanisms

We ran a multiple mediator model to examine whether either developmental status assessed in early childhood or educational attainment mediated the effect of institutional placement on cognitive functioning. Total, direct, and indirect effects are presented in Table 5. In addition, for the model including the four domains of cognitive functioning as outcome variables, all significant and marginally significant paths are depicted in Fig. 7.

The results show that the developmental status assessed in early childhood is a significant mediator of the relation between institutionalization and cognitive functioning in late adulthood. This was shown for the average score (indirect effect $\beta = -0.15$, $p < .01$), processing speed (indirect effect $\beta = -0.15$, $p < .05$), and perceptual reasoning (indirect effect $\beta = -0.14$, $p < .05$). The fact that the direct effects for perceptual reasoning and processing speed were substantially reduced and no longer significant when the mediator variables were included (paths for perceptual reasoning: $\beta_{c/c'} = -0.26/-0.07$, $p_{c/c'} = .002/.520$; paths for processing speed: $\beta_{c/c'} = -0.31/-0.13$, $p_{c/c'} = .000/.282$) indicates a complete mediation. In the analysis using the average score, a partial mediation

**Table 4**
Standardized coefficients for Model 1a and 1b.

| | WAIS: Average score | | WAIS: Verbal comprehension | | WAIS: Perceptual reasoning | | WAIS: Working memory | | WAIS: Processing speed | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1a | Model 1b | Model 1a | Model 1b | Model 1a | Model 1b | Model 1a | Model 1b | Model 1a | Model 1b |
| **Institutionalization** | | | | | | | | | | |
| IG | −0.39*** | | −0.17* | | −0.26** | | −0.40*** | | −0.31*** | |
| IG < 2.55 years[1] | | −0.25** | | −0.12 | | −16† | | −0.24* | | −0.21* |
| IG ≥ 2.55 years[1] | | −0.44*** | | −0.21** | | −0.37*** | | −0.41*** | | −0.37*** |
| **Nationality (Swiss)**[2] | −0.14† | −0.17* | −0.14 | −0.16† | 0.04 | −0.02 | 0.03 | 0.01 | −0.29** | −0.33*** |
| **Birth weight** | −0.03 | −0.06 | −0.05 | −0.07 | 0.03 | −0.01 | 0.02 | −0.00 | 0.01 | −0.02 |
| **Sex (Female)**[3] | −0.13* | −0.12† | −0.15* | −0.15* | −0.14* | −0.13* | −0.11 | −0.11 | 0.04 | 0.04 |
| $R^2$ | 0.12 | 0.15 | 0.04 | 0.05 | 0.10 | 0.15 | 0.19 | 0.20 | 0.07 | 0.10 |

*Note.* IG = institutionalized group. WAIS = Wechsler Adult Intelligence Test.
[1] Reference group = comparison group (CG).
[2] Dichotomous variable with "0 = foreign nationality and 1 = Swiss nationality".
[3] Dichotomous variable with "0 = male and 1 = female".
† $p < .10$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

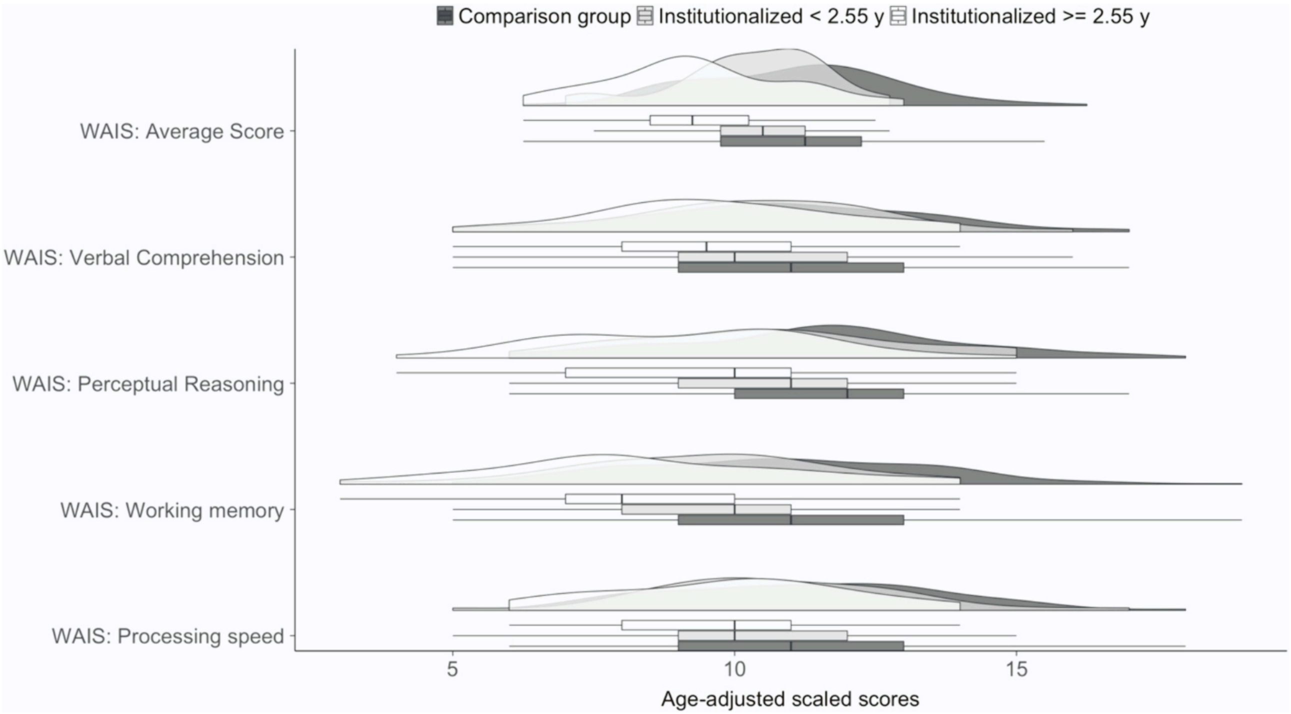


**Fig. 6.** Grouped plots for cognitive functioning at Wave 3 splitting the institutionalized group based on duration of institutionalization.

**Table 5**
Standardized coefficients for Model 2a (H2a & H2b).

| Outcome | Total effects | Direct effects | Indirect effects | | | $R^2$ |
|---|---|---|---|---|---|---|
| | β | β | Mediator | β | 95 % CI[1] | |
| WAIS: Average score | −0.37*** | −0.19* | Developmental status | −0.15** | [−0.94; −0.15] | 0.34 |
| | | | Educational attainment | −0.03 | [−0.37; 0.14] | |
| WAIS: Verbal comprehension | −0.16* | −0.06 | Developmental status | −0.07 | [−0.83; 0.21] | 0.23 |
| | | | Educational attainment | −0.03 | [−0.49; 0.19] | |
| WAIS: Perceptual reasoning | −0.24** | −0.07 | Developmental status | −0.15* | [−1.41; −0.11] | 0.24 |
| | | | Educational attainment | −0.02 | [−0.41; 0.15] | |
| WAIS: Working memory | −0.39*** | −0.31** | Developmental status | −0.07 | [−0.97; 0.32] | 0.24 |
| | | | Educational attainment | −0.02 | [−0.28; 0.11] | |
| WAIS: Processing speed | −0.29** | −0.13 | Developmental status | −0.14* | [−1.16; −0.02] | 0.25 |
| | | | Educational attainment | −0.03 | [−0.43; 0.16] | |

*Note.* WAIS = Wechsler Adult Intelligence Test.
[1] For indirect effects, the bootstrapped 95 % confidence interval bounds (based on 10,000 simulations) are reported. Total effect = c + a1*b1 + a2*b2; Direct effect = c; Indirect effect = a*b.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

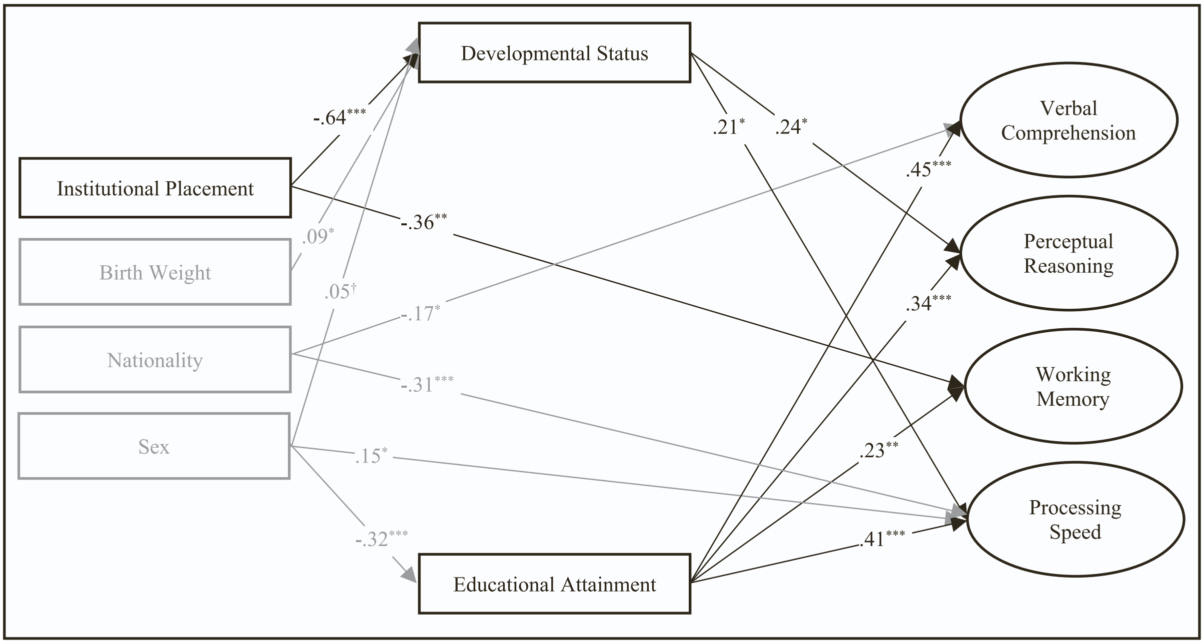


**Fig. 7.** Depiction of the significant paths in Model 2a (H2a & H2b)
Note. The depicted effects are standardized coefficients. †$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

was found ($\beta_{c/c'} = -0.39/-0.19$, $p_{c/c'} < .001/< .05$). In contrast, neither a significant direct effect ($\beta_{a2} = -0.07$, $p = .387$) that would indicate group differences in educational attainment nor a significant indirect effect on the average score or any domain of cognitive functioning could be found for the second mediator variable, educational attainment. Testing the contrasts between the indirect effects through the developmental status and through educational attainment, we found marginal significant effects for the average score ($p = .052$ [−0.88; 0.01]) and for processing speed ($p = .079$ [−1.39; 0.09]).

For the final analysis examining whether educational attainment mediated the effect of duration of institutionalization on cognitive functioning, we ran a simple mediator model using only the data for the institutionalized group. In line with model 2a, again, the direct effect on educational attainment was not significant. However, the effect size indicates a tendency that individuals with longer duration of institutionalization have lower educational attainment ($\beta a = -0.20$, $p = .127$). The indirect effects on cognitive functioning were not significant (Table 6).

## 4. Discussion

The present study investigated the association between psychosocial deprivation experienced in early childhood and cognitive functioning in late adulthood and explored potential underlying mechanisms.

### *4.1. Differences in cognitive functioning between individuals institutionalized as infants and the comparison group*

In line with our first hypothesis, we found that individuals in the institutionalized group scored lower in cognitive functioning in late adulthood (H1a). Our results provide strong support for the conclusion that these group differences in cognitive functioning are related to structural adversity in the institutions, firstly, because there were neither initial group differences nor longitudinal effects for birth weight. Given that birth weight is considered a robust marker of fetal growth and perinatal health (Walhovd et al., 2012), this indicates that the group differences in cognitive functioning cannot be explained by prenatal conditions and their effects on fetal growth and brain development. Secondly, because most children were institutionalized immediately after birth, we can also exclude postnatal exposure to the family environment as an explanation.

Given that cognitive functioning has been shown to predict important life outcomes such as economic success, life satisfaction, health, and longevity (Batty et al., 2007; Brown et al., 2021; Calvin et al., 2011; Gonzalez-Mulé et al., 2017; Gottfredson & Deary, 2004; Wraw et al., 2015), the finding that the negative impact of early institutionalization on cognitive functioning is still evident some 60 years later is highly relevant for understanding the breadth of the impact of early psychosocial deprivation. Notably, children in our study solely experienced psychosocial deprivation. This contrasts with studies in Romanian institutions after the fall of the Ceausescu regime, where children, in addition to psychosocial deprivation, also often suffered malnutrition and sanitary conditions were often poor (Groze & Ileana, 1996; Rutter, 1998). Consistent with this, the Bucharest Early Intervention Project (BEIP) showed that prolonged institutional care was not only associated with cognitive deficits but also with significant growth restrictions (King et al., 2023). In our cohort, the institutionalized and comparison groups did not differ significantly in BMI, height, or weight in adulthood (see Appendix, Table A.2). In addition to the extensive study documentation (Meierhofer & Keller, 1974), this lack of difference can be taken as further evidence that the children in our cohort were physically well cared for and solely experienced psychosocial deprivation. Therefore, our results emphasize the crucial importance of sensitive care and adequate cognitive stimulation beyond the satisfaction of basic physical needs for cognitive development across the lifespan.

When we looked at the four outcome domains separately, we found the strongest group differences for working memory. This is in line with a meta-analysis showing that working memory is the domain of cognitive functioning most impaired in individuals with ACEs (Masson et al., 2015). Likewise, studies that specifically focused on formerly institutionalized individuals have consistently found negative effects on working memory (Merz et al., 2013; Wade et al., 2019). These results also align with the findings of neuroimaging studies: Several studies have shown that children exposed to deprivation have decreased volume and altered function in frontoparietal regions (see systematic review by McLaughlin et al., 2019). These brain regions are typically activated during working memory tasks (Chai et al., 2018). In contrast, children who have been exposed to experiences of threat, such as abuse, show different patterns of brain changes (McLaughlin et al., 2019). This underscores the importance of distinguishing the types of ACEs and the outcomes.

When we divided the sample of institutionalized children by duration of institutionalization, we found that the negative effect of institutionalization was stronger for those individuals institutionalized 2.55 years or longer. This confirms hypotheses H1b and H2b and aligns with the dose–response effect found in previous studies, with longer exposure to institutionalization forecasting poorer outcomes (van IJzendoorn et al., 2020). Evidence suggests that this relation between duration of institutionalization and the developmental outcomes is not linear but exhibits a "step-function": Persistent deficits only emerge after a certain duration of exposure to psychosocial deprivation, but exposure prolonged beyond this duration does not further increase the risk of negative outcomes (Zeanah et al., 2011). In the English and Romanian Adoptees (ERA) study, for example, children were found to be at higher risk for persistent deficits when institutionalization lasted at least six months (Kreppner et al., 2007). In another study, however, this critical cut-off-point of six months could not be confirmed: even children who had been institutionalized for their first two to four years of life developed an IQ in the normal range (Tizard & Rees, 1974). One explanation for these contradictory results may lie in different care conditions: as described above, children in the Romanian institutions experienced more severe and more globally depriving conditions, whereas the children assessed by Tizard and Rees (1974) were solely exposed to emotional deprivation. This means that the caregivers provided children with good nutrition and cognitive stimulation, but were instructed not to develop close personal relationships with individual children. The conditions in our study, where children were also physically well cared for but received neither adequate cognitive nor emotional stimulation, lie between these two studies. This may explain why, in contrast to the Tizard study, we did find persistent negative effects on cognitive functioning but that the threshold at which exposure makes children more vulnerable to negative consequences in our study seems to be later than in the ERA study. Although our data did not allow direct comparison of different thresholds, our results indicate that longer duration of institutionalization under depriving conditions increases the risk of persistent deficits, even when children are physically well cared for.

To strengthen our conclusions and to rule out as alternative explanations that differences between individuals with a history of ACEs and individuals without ACEs may be explained primarily by outliers (Haugaard, 1998), we conducted additional analyses in which we excluded individuals with either extreme scores on duration of institutionalization or very low scores on cognitive functioning. The results, which can be found in the Appendix (see Table A.4), support our previous findings and speak against the assumption that individuals with a history of institutionalization are, in fact, rather similar to those without but differ only in the extreme groups.

**Table 6**
Standardized coefficients for Model 2b (H2c).

| Outcome | Total effects | Direct effects | Indirect effects | | | $R^2$ |
|---|---|---|---|---|---|---|
| | β | β | Mediator | β | 95 % CI[1] | |
| WAIS: Average score | −0.22[†] | −0.16 | Educational attainment | −0.07 | [−0.52; 0.11] | 0.31 |
| WAIS: Verbal comprehension | −0.10 | −0.01 | Educational attainment | −0.09 | [−0.91; 0.13] | 0.26 |
| WAIS: Perceptual reasoning | −0.21 | −0.17 | Educational attainment | −0.04 | [−0.63; 0.14] | 0.29 |
| WAIS: Working memory | −0.24 | −0.22 | Educational attainment | −0.03 | [−0.49; 0.26] | 0.10 |
| WAIS: Processing speed | −0.11 | −0.05 | Educational attainment | −0.06 | [−0.65; 0.09] | 0.37 |

*Note.* WAIS = Wechsler Adult Intelligence Test.
[1] For indirect effects, the bootstrapped 95 % confidence interval bounds (based on 10.000 simulations) are reported. Total effect = c + a1*b1 + a2*b2; Direct effect = c; Indirect effect = a*b.
[†] $p < .10$.

### *4.2. Developmental status and education as a potential mechanisms of group differences*

Our mediation analyses showed that children's developmental status in early childhood was a mechanism through which infant institutionalization influenced cognitive functioning in late adulthood (H2a). This indicates that these children's early developmental deficits following psychosocial deprivation were severe enough to affect functioning over 60 years later. This supports the early experience hypothesis, emphasizing the importance of the first years of life for subsequent development. A predictive effect of the developmental status assessed in early childhood on cognitive functioning in late adulthood was shown for perceptual reasoning and processing speed, but not for verbal comprehension or working memory. This may be because verbal comprehension is the only subtest used here that assesses crystallized abilities (Benson et al., 2010). Crystallized abilities are more strongly influenced by environmental factors than fluid abilities and can thus be more strongly modified by learning experiences later in life (Schalke et al., 2013). Moreover, the lack of association between children's developmental status and working memory may be related to the type of task: It is assumed that basal forms of working memory in infancy can best be assessed with delayed response tasks (Pushina et al., 2005). Developmental tests such as the Brunet and Lézine (1951) test do not include this kind of task or any other specific working memory tasks and may therefore have less predictive value.

We also examined educational attainment as a second mediator. Disconfirming our hypothesis (H2b), the two groups did not substantially differ in educational attainment, and no significant indirect effect on cognitive functioning was found. This means that, contrary to our expectations, we did not find that institutionalization significantly limited individuals' access to higher education in our cohort. In the literature, the negative association between institutionalization and educational attainment is attributed to lack of encouragement, lack of personal and financial support, and instability due to multiple care and school changes (Jackson & Cameron, 2012; Rutman & Hubberstey, 2018). In our study, individuals were institutionalized for an average of four years and then returned to their biological family or lived with foster or adoptive families. Accordingly, after deinstitutionalization, they may have experienced a stable, supportive environment and thus may have had somewhat similar educational opportunities to children in the comparison group. The results in the within-group analyses were also not significant (H2c), but the effect size shows a trend towards longer duration of institutionalization associating with lower educational attainment. This may indicate that prolonged institutionalization affects educational opportunities, for example, due to unstable placement and limited caregiver support.

Notably, our data showed that sex was the strongest predictor of educational attainment (both in the between- and the within-group analyses). This may be explained by typical historical gender norms, as various studies have shown that gender inequalities in education have decreased more slowly in Switzerland than other European countries and that Switzerland is one of the few Western countries where men still have higher educational opportunities than women (Hadjar & Uusitalo, 2016; Van Hek et al., 2016).Overall, our results indicate that the long-term effects of institutionalization are more likely attributed to significant developmental deficits rather than to indirect effects associated with the institutionalization, such as limited access to educational opportunities. In line with the early experience hypothesis, this suggests that early institutionalization involving psychosocial deprivation can lead to profound and lasting impacts on individuals' cognitive functioning throughout life. The fact that the negative effects manifested in early childhood and persisted over time also indicates that for cognitive development a direct lasting effect of psychosocial deprivation can be assumed. This contrasts from the literature on mental health outcomes, where some studies found evidence of latent vulnerability, i. e. that individuals do not immediately show negative outcomes after adverse experiences, but that these individuals may carry hidden or dormant vulnerabilities that become apparent later in life, triggered by certain circumstances or stressors (McCrory & Viding, 2015).

### *4.3. Strengths and limitations*

To the best of our knowledge, this study is the longest follow-up investigation of individuals institutionalized in infancy. The availability of a population-based dataset of children who were institutionalized from a very early age, the absence of baseline differences in birth weight compared to a comparison group, which could have indicated limited prenatal care, and the fact that these children lacked emotional and cognitive stimulation but received adequate physical care, render this study uniquely informative for gaining insight into the long-term consequences of psychosocial deprivation into late adulthood. Because longitudinal studies at this scale are challenging to implement for several reasons and raise many ethical issues (Birmingham & Doyle, 2009), most studies on the effects of ACEs in adulthood are purely cross-sectional and use retrospective, self-reported data on ACEs, which increases the risk of recall bias and limits causal inferences (Reuben et al., 2016). In contrast, our study uses prospective data from early childhood onwards gathered with standardized tests that increase the validity of our results and allow meaningful comparisons over time and across groups. Another strength of this study is the availability of a matched comparison group of individuals who grew up in families in the same geographic region at the same time. This allows us to control for zeitgeist-dependent effects; moreover, local site-specific norms have been shown to be more sensitive for detecting differences in cognitive functioning than published norms collected from a broader population (Andruchow et al., 2022). Other strengths of this study include the differentiation of multiple domains of cognitive functioning, which allows the detection of effects that may be evident only for specific outcome domains (Luthar et al., 2000), and the use of a multiple mediator model that accounts for shared variance among mediators and thus models the complexity of an association more accurately than simple mediation models (Coutts & Hayes, 2022; Preacher & Hayes, 2008).

Nevertheless, the study also has some limitations: Despite the success of recruiting nearly 50 % of eligible individuals for data collection in late adulthood, which is comparable to the follow-up rates of the few other multi-decade longitudinal studies (e.g., 52.5 % in the British *'1958 National Child Development Study'*; Centre for Longitudinal Studies, 2024), the data missing from this follow-up assessment constitutes a limitation. However, power-analyses indicated that we had an adequate sample size to detect medium to large effect sizes: a preliminary a priori power-analysis for a *t*-test for independent samples with an alpha-error of 0.05 and a power of 0.80 showed that a total sample size of 102 participants would be required to detect medium effect sizes. We further conducted a post-hoc power analysis exemplarily using a t-test for independent samples comparing the average score of cognitive functioning between the institutionalized and the comparison group (Table 1). Given the sample size ($n = 228$) and the effect size ($d = 0.67$) the achieved statistical power was calculated to be $>0.99$. Moreover, participation in the follow-up assessment proved to be nonselective: those who participated in wave 3 did not differ significantly from those who dropped out in baseline characteristics or developmental status in early childhood, therefore excluding systematic bias. This is particularly noteworthy because long-term longitudinal studies with vulnerable samples are at high risk for selective attrition (e.g. Salthouse, 2014).

Another limitation of the study is that we did not test for different cut-off points for the effect of duration of institutionalization. This would have allowed us to draw conclusions about whether our data also reflects a step-function. One of the main reasons why we chose the data-driven approach and dichotomized the variable using the median is that other cut-offs, such as the six-month threshold used in the ERA study, would have resulted in very uneven distributions with very small numbers of cases for some categories due to the relatively large variance in the duration of institutionalization in our sample. Such an approach would have made it difficult to detect effects due to power issues. Consequently, whereas our results provide solid indication that a longer duration of institutionalization increases the risk of long-term cognitive deficits, our data does not allow us to draw conclusions regarding a specific age or limit beyond which negative effects are expected. This will, among other factors, also depend on the severity of the deprivation. In addition, for our cohort, data on duration of placement were not collected for all children at the same age because the recruitment period ranged from 1969 to 1973. As a result, the potential maximum duration of placement differed, but the effect of this becomes less influential through dichotomization than in a linear approach. However, to cross-check the stability of our results using the dichotomized variable, we conducted additional analyses employing a linear approach, which yielded highly comparable results (see Appendix, Table A.3 for details). A further limitation of this study is that we only used single indicators for each domain of cognitive functioning, although accounting for measurement errors with the test–retest reliability reported in the manual increased accuracy, at least to some degree. Moreover, the validity of this approach is also supported by the fact that the analyses using the average score align closely with the results of the analyses at the subscale level. A further limitation of this study is that we only have detailed data on placement trajectories after wave 1 for a part of the sample that was tested at wave 2 and were therefore unable to systematically include this information in the analyses. Lastly, because there is no data between wave 1 in early childhood and wave 3 in late adulthood, information on the mechanisms of change is limited.

## 5. Conclusion

In summary, our results show that even if children's physical needs are well cared for, lack of cognitive and emotional stimulation in early childhood significantly threatens further development and can lead to persistent deficits in cognitive functioning that are still evident some 60 years later. Longer duration of institutionalization further increased the risk of lower cognitive functioning, indicating a dose–response effect. Our analyses showed that the long-term negative effect of institutionalization was primarily explained by children's developmental status and not by having less access to higher education as an indirect effect of institutional care. This indicates that psychosocial deprivation in early childhood causes developmental deficits that are so severe that they cannot be fully compensated and have profound impacts on cognitive functioning across the lifespan. In line with the early experience hypothesis, this shows that early life conditions have lasting effects on human development, even into late adulthood. This finding is highly relevant from a global perspective, as institutional care involving psychosocial deprivation, very similar to the conditions of the cohort in this project, is still current practice in many countries today (Berument, 2013; Koch & Franzsen, 2017; Lee, 2000; The St. Petersburg–USA Orphanage Research Team, 2005). In order to investigate the long-term effects into old age, further follow-up assessments are planned. One possible hypothesis is that the deficits in cognitive functioning at the age of 60 might set off a series of cascading processes later in life that impair the healthy ageing of the formerly institutionalized individuals. This is consistent with the cognitive reserve theory (Stern, 2003), according to which individuals with lower cognitive abilities are less able to compensate for the social, psychological, and neurobiological effects of cognitive ageing and dementia, and may therefore exhibit more pronounced cognitive decline and premature death.

## CRediT authorship contribution statement

**Hannah Sand:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Fabio Sticca:** Writing – review & editing, Supervision, Methodology, Investigation. **Flavia M. Wehrle:** Writing – review & editing, Supervision, Data curation. **Dominique A. Eichelberger:** Writing – review & editing, Investigation, Data curation. **Heidi Simoni:** Writing – review & editing, Funding acquisition, Conceptualization. **Oskar G. Jenni:** Writing – review & editing, Funding acquisition, Conceptualization. **Patricia Lannen:** Writing – review & editing, Funding acquisition, Conceptualization.

## Data availability

The authors do not have permission to share data.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chiabu.2024.106917.

## References

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