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Ethnic differences in timing and duration of exposure to neighborhood disadvantage during childhood

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ABSTRACT

This paper examines ethnic differences in childhood neighborhood disadvantage among children living in the Netherlands. In contrast to more conventional approaches for assessing children's exposure to neighborhood poverty (e.g., point-in-time and cumulative measures of exposure), we apply sequence analysis to simultaneously capture the timing and duration of exposure to poor neighborhoods during childhood. Rich administrative microdata offered a unique opportunity to follow the entire 1999 birth cohort of the Turkish, Moroccan, Surinamese, and Antillean second generation and a native Dutch comparison group from birth up until age 15 (N = 24,212). Results indicate that especially Turkish and Moroccan children had higher odds than native Dutch children to live in a poor neighborhood at any specific stage during childhood, but particularly throughout the entirety of childhood. Although ethnic differences in neighborhood income trajectories became smaller after adjusting for parental and household characteristics, a substantial proportion of the differences remained unexplained. In addition, the impact of household income on children's neighborhood income trajectories was found to be weaker for ethnic minority children than for native Dutch children. We discuss our findings in relation to theories on spatial assimilation, place stratification, and residential preferences.

1. Introduction

The importance of residential neighborhoods in shaping children's lives has been studied extensively (Pebley & Sastry, 2004). Growing up in a deprived neighborhood is thought to impede children's well-being and development due to, amongst others, a lack of successful role models, exposure to high levels of crime within their local communities, scarce institutional resources, and environmental health hazards (Galster, 2012). Motivated by the relevance of the neighborhood context for children in particular, various studies have focused on children's neighborhood socioeconomic status as an outcome in itself. Previous research in the US has shown substantial racial and ethnic inequality in this regard, with black children having much higher odds of residing in poor neighborhoods than children from white families (Briggs & Keys, 2009; Sharkey, 2008; Timberlake, 2007, 2009). In European research, however, little attention has been paid to factors shaping children's neighborhood environments (for exceptions, see Morris, 2017; Van Ham, Hedman, Manley, Coulter, & Östh, 2014).

Prior studies have often measured children's neighborhood socioeconomic status at a single point in time. These measures are increasingly criticized because children's neighborhood characteristics may change over time, either because families move to a different neighborhood or because neighborhoods themselves change over time (Kleinepier & van Ham, 2017; Sharkey & Faber, 2014). In response, recent work has developed more dynamic measures of children's neighborhood experiences, mainly by studying the duration of exposure to poor neighborhoods (Wodtke, Harding, & Elwert, 2011). For example, Timberlake (2007) showed that racial differences in the cumulative exposure to poor neighborhoods during childhood are greater than racial differences at any single point in time. However, while measures of duration of exposure avoid some of the shortcomings of point-in-time measures of neighborhood quality, an exclusive focus on duration of exposure obscures another potentially important aspect of children's neighborhood histories: the timing of exposure. Despite many studies showing that family poverty during early childhood versus family poverty during adolescence has heterogeneous effects on later outcomes (e.g., Wagmiller, Lennon, Kuang, Alberti, & Aber, 2006), research on neighborhood deprivation has largely neglected such variation in children's exposure to disadvantage (for exceptions, see Wodtke, 2013; Wodtke, Elwert, & Harding, 2016).

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This paper examines ethnic differences in childhood exposure to poor and nonpoor neighborhoods among children in the Netherlands, focusing on the second generation of the four largest non-Western immigrant groups in the country (Turks, Moroccans, Surinamese, Antilleans) and the native Dutch population. Our study has three core aims. The first aim is to better capture ethnic differences in children's exposure to neighborhood disadvantage by using sequence analysis to simultaneously take into account the duration and timing of exposure (Abbott, 1990; Abbott & Tsay, 2000). The second aim of this study is to examine the extent to which ethnic differences in children's patterns of exposure to neighborhood disadvantage can be explained by observed parental and household characteristics. Drawing on different theoretical perspectives, differences in children's neighborhood socioeconomic status may be related to observed factors (e.g., family income, household size) and unobserved factors in our dataset (e.g., preferences, discrimination) (Timberlake, 2009). Research furthermore suggests that, at least in the US context, the impact of socioeconomic status on exposure to neighborhood poverty differs by race/ethnicity (South & Crowder, 1997; Swisher, Kuhl, & Chavez, 2013). As such, the third aim of this study is to assess whether ethnicity moderates the relationship between household income and children's exposure to neighborhood deprivation.

2. Background

In this section, we outline the relevant literature on ethnic differences in children's neighborhood socioeconomic status. It is worth noting that families with young children have been found to change residence relatively frequently (Tønnessen, Telle, & Syse, 2016). Recent empirical research further indicates that there is substantial variation over time in children's neighborhood characteristics, particularly among those who moved (Kleinepier & van Ham, 2017). These findings highlight the need to take a longitudinal approach to the study of children's neighborhood socioeconomic status. Importantly, furthermore, children usually do not have a choice in where they live until they reach the age of maturity, and so their neighborhood histories depend on the choices and constraints faced by their parents. In the remainder of this section, we therefore focus on parental and household characteristics – rather than characteristics of the children themselves – in order to formulate hypotheses on ethnic differences in children's neighborhood status. For context, we first provide background on why and when the ethnic minorities' parents in this study arrived in the Netherlands as well as their position in Dutch society.

2.1. Migrants in the Netherlands

Currently, about one in five of the 17 million inhabitants of the Netherlands has an immigrant background, i.e. has at least one parent born abroad, including those born abroad themselves (first generation) and those born in the Netherlands (second generation). These people can be about equally divided into those of Western and non-Western origin. Turks, Moroccans, Surinamese, and Antilleans make up a sizable share of the population of non-Western origin, comprising respectively 2.3, 2.3, 2.1, and 0.9 percent of the total population of the Netherlands. All other origin groups are considerably smaller (especially the second generations) and cover a heterogeneous population in terms of migration history and time of residence in the Netherlands (Statistics Netherlands, 2017).

Turkish and Moroccan immigrants were initially recruited in the 1960s and early 1970s in order to fill unskilled occupations in the Netherlands. They were typically low or uneducated men who originated from the rural parts in their origin countries (Vermeulen & Penninx, 2000). Although these so-called 'guest workers' were expected to stay temporarily in the Netherlands, many decided to permanently settle in the Netherlands and were gradually joined by their wife and children in the 1970s and early 1980s. Many of these children, in turn, married partners from Turkey and Morocco in the 1980s and 1990s.

Surinam and the Netherlands Antilles are former Dutch colonies. Surinamese and Antillean immigrants were thus usually familiar with the Dutch language and culture upon arrival in the Netherlands. Many Surinamese immigrants moved to the Netherlands just before Surinam obtained its independence in 1975, as they were able then to retain Dutch citizenship. Migration from the Antilles has traditionally been dominated by short-term student migration, but limited employment opportunities in the Antilles in the 1980s and 1990s have led to more diverse and more permanent migration flows towards the Netherlands (Oostindie, 2011).

All four ethnic minority groups are more likely to be socioeconomically disadvantaged than native Dutch, but in general Turks and Moroccans experience a larger gap in educational attainment and labor market outcomes with respect to the native Dutch than do Surinamese and Antilleans. For instance, around 33 percent of Turkish and Moroccan immigrants has attained no more than primary education, as compared to some 15 percent among Surinamese and Antillean immigrants and 6 percent among native Dutch (Huijnk & Andriessen, 2016). Consequently, particularly Turkish and Moroccan immigrants are facing difficulties in finding employment, and if they do, they are often in low-skilled and unstable jobs (ibid). The homeownership rate is also much lower among the ethnic minority groups than among the native Dutch (71%): Moroccans are the least often owner-occupiers (14%), followed by Antilleans (32%), Turks (34%), and Surinamese (43%) (Zorlu, Mulder, & van Gaalen, 2014).

Finally, there are important demographic differences between the ethnic groups under study. Due to relatively high fertility rates[1] and multigenerational living arrangements, Turkish (M = 3.7 persons) and Moroccan (M = 3.8 persons) households are almost twice as large as those of the native Dutch, while the average size of Surinamese (M = 2.6 persons) and Antillean (M = 2.4 persons) households is close to the Dutch average of 2.2 persons (Heering, de Valk, Spaan, Huisman, & van der Erf, 2002). Single mother families are much more common among Surinamese and Antilleans than among Turks, Moroccans, and native Dutch, with respectively 17, 15, 4, 7, and 2 percent of women born in 1982/83 living with their child(ren) but without a partner in young adulthood (Kleinepier & de Valk, 2016). In line with this, previous research indicates that Surinamese and Antillean migrants have higher union dissolution rates than the native Dutch, while there is no difference between the native Dutch and Turks and Moroccans in this regard (Rooyackers, Das, & de Valk, 2015).

2.2. Spatial assimilation

Spatial assimilation theory contends that immigrants often start out at the bottom of the socioeconomic ladder upon arrival in a new society. Consequently, many immigrants initially settle in poor neighborhoods with a relatively high proportion of ethnic minorities, sometimes referred to as 'ethnic enclaves' (Massey & Denton, 1985). From the spatial assimilation perspective, ethnic enclaves are undesirable residential areas. The key expectation is that by improving their socioeconomic position and becoming more proficient in the language of the host society, immigrants will move away from ethnic enclaves to higher socioeconomic status neighborhoods (Alba & Logan, 1993). Thus, the spatial assimilation model predicts that immigrants' neighborhood attainment goes hand-in-hand with their social and economic mobility. It has been argued, however, that the process of assimilation and integration may take many years or even multiple generations to complete, especially when the cultural and linguistic distance between the country of origin and destination is large (Crowder & South, 2005).

[1] In 2005, the total fertility rate (TFR) was 2.17 among Turkish immigrants, 3.22 among Moroccan immigrants, and 1.87 among the native Dutch (Garssen & Nicolaas, 2008).

Thus, when 'full assimilation' has yet to take place, ethnic differences in children's neighborhood status may simply reflect ongoing group differences in their parents' resources.

Regarding socioeconomic predictors of neighborhood attainment, previous research has shown that children whose parents are highly educated, work in high-paid jobs, and own rather than rent their dwelling, are less likely to live in poor neighborhoods (De Vuijst, van Ham, & Kleinhans, 2017; South, Huang, Spring, & Crowder, 2016). Furthermore, longitudinal studies indicate that abrupt changes of financial circumstances within families are important drivers of change in neighborhood status. For example, recent research indicates that paternal job loss increases the probability of moving to a deprived neighborhood, suggesting that economic pressures of job loss may force families to 'downgrade' their neighborhood status (Morris, 2017). As previously outlined, the ethnic minorities' parents under study are more likely to have a disadvantaged socioeconomic status than the parents of native Dutch children. This may explain ethnic differences in children's exposure to neighborhood disadvantage.

Research on neighborhood attainment has further emphasized the role of sociodemographic characteristics, particularly household size and parental union status. Children from single parents and larger families are more likely than children from smaller and intact families to grow up in poor neighborhoods (South et al., 2016; Wodtke et al., 2011). Similar to paternal job loss, children whose parents recently divorced or separated have a higher risk of moving into a deprived neighborhood (Morris, 2017; Wodtke et al., 2011). As discussed before, Turkish and Moroccan households are generally larger than those of the native Dutch, while single mother families and partnership dissolution are more common among Surinamese and Antilleans.

2.3. Place stratification and residential preferences

The place stratification model problematizes the notion of spatial assimilation theory that ethnic minorities are fully able to convert their socioeconomic resources into better quality neighborhoods. Accordingly, the neighborhood attainment of ethnic minorities is further constrained by prejudice and discrimination by various actors in the housing and credit market (Charles, 2003; Massey & Denton, 1985). Direct empirical support for effects of discrimination on ethnic inequality in neighborhood socioeconomic status has been limited, however, predominantly due to a lack of suitable data (for an exception, see Carpusor & Loges, 2006). The typical analytical approach to test the place stratification model has been to control for socioeconomic and sociodemographic characteristics and interpret the ethnic residual as the effects of discrimination. For example, Zorlu, Mulder, and van Gaalen (2014) found a particularly large unexplained gap in homeownership between native Dutch and Moroccan immigrants. The authors argue that, given that Moroccans in particular are often perceived as a problematic group in terms of integration into the Dutch society, the unexplained difference in homeownership rates may be related to ethnic discrimination.

However, ethnic residuals in neighborhood socioeconomic status can also reflect other, non-discriminatory factors. For example, ethnic concentrations can give rise to ethnic social networks, which may provide support systems and an environment where people share similar norms and values (Adelman, 2005; Zhou, 2009). The presence of coethnics and ethnic social networks may therefore attract immigrants to neighborhoods with higher shares of immigrants. Moreover, Zorlu and Mulder (2010) suggest that preferences to live near family members are stronger for ethnic minorities than for the native Dutch. Finally, Kullberg, Vervoort, and Dagevos (2009) show that non-Western immigrants in the Netherlands also prefer to live in close proximity to ethnic-specific facilities, such as ethnic shops, restaurants, and certain religious institutions. These facilities are typically located in neighborhoods with a relatively high share of ethnic minorities, which generally have higher poverty rates as well. Thus, whereas spatial assimilation and place stratification theory presume that people will or attempt to move to more affluent neighborhoods when their socioeconomic status improves, the literature on residential preferences suggests a more voluntary clustering of immigrants in less affluent neighborhoods.

Theories on place stratification and residential preferences further suggest that the relationship between parental resources and children's neighborhood socioeconomic status may differ by ethnicity. There are two competing lines of reasoning in this regard. On the one hand, the 'strong' version of the place stratification model assumes that immigrant parents are less able to convert their resources into more advantaged neighborhoods due to discrimination on the housing and credit markets (Alba & Logan, 1993). In addition, preferences to live close to coethnics may suggest that immigrant parents will reside in poor neighborhoods also when they have the opportunity to live in more affluent areas. From this perspective, it can be argued that the effect of parental resources on children's neighborhood status is weaker for ethnic minorities than for the native population. Indeed, previous research found that the impact of higher education on young adult's neighborhood income status was weaker for ethnic minorities than for the native Dutch (De Vuijst et al., 2017).

On the other hand, the 'weak' version of place stratification theory posits that parental resources will have a stronger effect on the likelihood of growing up in a nonpoor neighborhood for ethnic minority children than for children of native-born parents (Alba & Logan, 1993). The logic of the weak version is that the ethnic majority population is so advantaged that very few of them live in the most disadvantaged neighborhoods. This would imply that socioeconomic resources are hardly predictive of the native population's likelihood to live in nonpoor neighborhoods. In line with the 'weak' version of the place stratification model, South and Crowder (1997) showed that the effect of educational attainment on the likelihood of moving out of poor neighborhoods is stronger for blacks than for whites. Likewise, in the Dutch context, Uunk (2017) observed a stronger effect of individual income on the likelihood of owning a home for Turkish and Moroccan immigrants than for the native Dutch population.

2.4. Hypotheses

Based on the theories and empirical studies discussed above, we formulate three hypotheses that are tested in the empirical section of this paper. First, we expect that Turkish, Moroccan, Surinamese, and Antillean second-generation children are more likely than native Dutch children to be exposed to neighborhood deprivation during their childhood (*Hypothesis 1*). Although the underlying mechanisms are distinct, spatial assimilation, place stratification, and residential preference theories all point to the expectation that ethnic minority children are more likely than ethnic majority children to reside in lower-income neighborhoods.

The theories do differ, however, in their view on the importance of parental and household characteristics in this regard. While spatial assimilation theory suggests that ethnic differences in children's neighborhood trajectories are explained by parental and household resources, theories on place stratification and residential preferences suggest that group differences are attributed to other, unobserved factors. Our second hypothesis, therefore, is that differences in children's neighborhood trajectories between Turkish, Moroccan, Surinamese, and Antillean second-generation children and native Dutch children are partially mediated by parental and household characteristics (Hypothesis 2).

Finally, given the contrary views on the moderating effect of ethnicity on the relationship between parental resources and children's neighborhood status, we propose an undirectional hypothesis. Previous research showed that the most important determinant of neighborhood socioeconomic status is the ability to pay for a residence in low-poverty neighborhoods (Timberlake, 2009). Because our data provide no

information on people's savings or other financial assets, we use household income from employment and benefits as a proxy for the ability of households to live in more affluent neighborhoods. That is, we hypothesize that the effect of household income on children's neighborhood trajectories is different for ethnic minority children than for native Dutch children (Hypothesis 3).

3. Data and methods

3.1. Data

Our analyses are based on longitudinal microdata derived from the System of Social statistical Datasets (SSD), made available by Statistics Netherlands (Bakker, van Rooijen, & van Toor, 2014). The SSD consists of several interlinked administrative registers, including the municipal population register and tax register, which contain demographic and socioeconomic information on the entire population of the Netherlands. Data were available for the period 1999–2014. We select all Turkish (N = 5598), Moroccan (N = 5702), Surinamese (N = 4147), and Antillean (N = 1367) second-generation children and a 5% random sample[2] of native Dutch children (n = 7398) who were born in the Netherlands in 1999. We exclude a small group of children who themselves and/or whose both parents died or emigrated during the observation period to ensure that each child is observed over a span of 16 years, i.e. from birth in 1999 up until age 15 in 2014. In total, our research population includes 24,212 children.

3.2. Measuring neighborhood quality

The SSD provides unique geo-referenced information, allowing us to identify the residential neighborhood of each individual at different spatial scales. We operationalize neighborhoods using 500 × 500 m grid cells, which is consistent with the approach of previous research using the same dataset (e.g., De Vuijst et al., 2017; Kleinepier & van Ham, 2017). At the beginning of the observation period in 1999, there were 85,469 inhabited 500 × 500 m grid cells in the Netherlands, containing 181 inhabitants on average. As compared to standard administrative units (e.g., zipcode areas), grid cells have the advantage that they are smaller and therefore more likely to depict inhabitants' perceived neighborhood environment (Coulton, Jennings, and Chan, 2013). Moreover, the boundaries of these grid cells remain constant over time, which is crucial when studying children's neighborhood histories. A disadvantage of grid-defined neighborhoods is, however, that they are based on geographical coordinates and therefore ignore natural or man-made barriers, such as railroads and rivers. As a robustness check, we replicated our findings using 100 × 100 m grids. Although the differences between ethnic groups were generally somewhat larger when using these smaller grid cells, our substantive conclusions did not change (see Supplementary data Appendix A for details).

In order to measure children's neighborhood socioeconomic status, we use data on the full population to compute the average individual monthly income in each 500 × 500 m grid cell, for each year of observation. While we recognize that neighborhood disadvantage can be measured with a wide-variety of indicators, we use the average income in the neighborhood due to its close relationship with the underlying social processes thought to be responsible for neighborhood effects (Wodtke, 2013). Individual income was measured as the sum of income from a variety of sources, including income from wages, self-employment, pensions, social security, and student loans.

Because sequence analysis explicitly views life course data as being framed into discrete time units, we discretized the continuous measure of the neighborhoods' average income into quintiles from the poorest to the wealthiest of grid cells. This follows the convention in the literature (e.g., De Vuijst et al., 2017; Lee, Smith, & Galster, 2017; Van Ham et al., 2014). We treat the top 20 percent of the neighborhood income distribution as affluent, the bottom 20 percent as deprived, and the remaining 60 percent as middle-income neighborhoods. Quintiles 2 to 4 were grouped because we are primarily interested in children's duration and timing of exposure to deprived neighborhoods (i.e., Quintile 1). By specifying each quintile separately, the cluster analysis (see next section) did not distinguish differences in timing of exposure to deprived neighborhoods as unique classes. In addition, due to the concentration of incomes around the mean, the differences in income between Quintiles 2–4 were not very large.

3.3. Independent variables

Ethnicity of the children is based on the country of birth of their parents (our sample only includes children who were born in the Netherlands). Following the standard definition of Statistics Netherlands, children with at least one parent born abroad were classified as second-generation Turkish, Moroccan, Surinamese, or Antillean, depending on the country of birth of the parent(s). If both parents were born abroad, but in different countries, the country of birth of the mother is dominant as was suggested by Rumbaut, (1994).Those with both parents born in the Netherlands are classified as native Dutch. *Mixed parentage* is a dummy variable denoting whether or not the child has one foreign-born and one native-born parent.

Parental educational level is derived from the Central Register for Enrolment in Higher Education. This register indicates whether a person has obtained a degree in higher education (i.e., bachelor degree or higher) in the Netherlands from 1986 onwards. Unfortunately, this means that we have no information on degrees obtained abroad or before 1986. We therefore assess the educational level of the father and the mother separately using three categories: 1 = low/medium educated, 2 = highly educated, and 3 = unknown. *Parental employment status* is measured by dividing the number of years that the father / mother was employed by 16 (total years of observation). *Equivalent household income* is constructed in several steps. We first calculate the children's average monthly household income for each year of observation and correct all values for inflation relative to the base year 1999. Because the needs of a household grow with each additional member, but in a disproportionate way, we divide the total household income in each year by the square root of household size in the given year (see OECD, 2013). We then calculate the mean equivalent household income over the years 1999–2014 and use a natural logarithmic specification of this variable to account for the typical right-skewed distribution of income. *Housing tenure* is a dummy variable indicating whether the parental dwelling in 1999 was owner-occupied.

Residential mobility indicates the number of times the child changed residences during the observation period. In order to scrutinize a potential curvilinear effect, we converted the variable into a set of dummy variables: 1 = no moves, 2 = one move, 3 = two moves, and 4 = three or more moves. The latter were grouped together because few children had changed residence more than three times (N = 803; 3.3%). *Household size* is measured as a continuous variable indicating the number of people living in the same household as the child in 1999 (including the child). Only a very small number of households consisted of more than 12 persons (N = 46; 0.2%); the latter are therefore grouped at the level of 12 people. *Parental union status* is distinguished into four categories: (1) parents remained together, (2) parents never lived together after child was born, (3) parents divorced, separated, or one parent died during observation period, and (4) parents started living together after initially living apart. *Age difference with parents* is measured linearly in years. We account for this since the reasons for and outcomes of moving may change throughout the life course (South et al., 2016). Table 1 presents an overview of the independent variables

[2] We take a random sample here due to memory and computing power limitations (cf. Kleinepier & de Valk, 2016).

Table 1
Descriptive statistics of independent variables, by ethnicity: Proportion or Mean (SD).

	Turkish (N = 5598)	Moroccan (N = 5702)	Surinamese (N = 4147)	Antillean (N = 1367)	Dutch (N = 7398)
Mixed parentage	0.21	0.12	0.41	0.56	0.00
Father's educational level					
Low / medium	0.35	0.34	0.25	0.23	0.37
High	0.09	0.08	0.15	0.16	0.34
Unknown	0.56	0.57	0.60	0.60	0.30
Mother's educational level					
Low / medium	0.41	0.36	0.34	0.36	0.41
High	0.10	0.10	0.22	0.25	0.36
Unknown	0.49	0.54	0.44	0.39	0.23
Father's labor participation	*0.72 (0.33)*	*0.61 (0.39)*	*0.71 (0.38)*	*0.62 (0.42)*	*0.92 (0.20)*
Mother's labor participation	*0.36 (0.34)*	*0.27 (0.34)*	*0.66 (0.35)*	*0.57 (0.38)*	*0.73 (0.34)*
Log household income (mean centered)	*−0.18 (0.46)*	*-0.32 (0.44)*	*0.08 (0.54)*	*−0.01 (0.60)*	*0.34 (0.48)*
Parents homeowners	0.22	0.08	0.37	0.31	0.76
Residential mobility					
0 moves	0.40	0.45	0.31	0.31	0.48
1 move	0.40	0.40	0.36	0.36	0.34
2 moves	0.14	0.10	0.19	0.17	0.11
≥3 moves	0.07	0.05	0.14	0.16	0.07
Household size	*4.33 (1.31)*	*4.55 (1.66)*	*3.68 (1.10)*	*3.72 (1.17)*	*3.81 (1.02)*
Parental union status					
Stable union	0.74	0.78	0.48	0.43	0.82
Dissolution	0.04	0.04	0.20	0.30	0.02
Never lived together	0.19	0.16	0.24	0.18	0.15
Started living together	0.03	0.02	0.08	0.08	0.01
Age difference with father	*30.46 (5.40)*	*34.63 (6.53)*	*33.15 (5.99)*	*32.58 (6.52)*	*33.51 (4.71)*
Age difference with mother	*27.50 (5.07)*	*28.82 (5.63)*	*29.95 (5.15)*	*29.84 (6.08)*	*31.14 (4.15)*

Note: Mean (SD) in italics. Proportions may not add to 1.00 due to rounding.
Source: System of Social statistical Datasets (SSD).

used in our analyses.

3.4. Analytic strategy

We apply sequence analysis to simultaneously capture the timing and duration of exposure to neighborhood disadvantage during childhood (Abbott, 1990; Abbott & Tsay, 2000). In sequence analysis, each individual life course trajectory is represented as a string of characters. Each child is observed from birth up to the age 15 on an annual basis. The number of possible combinations between these 16 years of observation and the three states (i.e., deprived, middle-income, or affluent neighborhood) is very large and thus raises problems of complexity when comparing the trajectories. Therefore, we identify subtypes of children's neighborhood trajectories to reduce the large number of distinct sequences into groups that can be easily interpreted.

We first calculate optimal matching (OM) distances between all children's neighborhood trajectories using R's TraMineR package (Gabadinho, Ritschard, Müller, & Studer, 2011). The OM algorithm measures pairwise distances between sequences by establishing how much it 'costs' to transform one sequence into another in terms of three elementary operations: insertion, deletion, and substitution. A cost is assigned to each of the operations by the researcher. We set insertion/deletion costs to 1 and define substitution costs as the inverse of transition frequencies, assigning higher substitution costs to less common transitions. This approach has been used frequently in the past because empirically-defined substitution costs reduce subjectivity (e.g., Kleinepier & de Valk, 2016; Widmer & Ritschard, 2009).

After OM distances have been calculated, we develop a typology of children's neighborhood trajectories using partitioning around medoids cluster analysis. In this clustering method, the number of clusters needs to be specified in advance. We therefore test a range of cluster solutions (2–20 cuts) and use the average silhouette width (ASW) criterion to select the 'optimal' number of clusters of neighborhood trajectories. As a robustness check, we reconstructed the typology using different cost settings in OM and Ward's clustering algorithm. Reassuringly, only minor differences were observed (see Supplementary data Appendix B).

The cluster analysis results in a categorical variable that represents different types of neighborhood trajectories throughout childhood. This is our dependent variable for the remainder of the analyses. We analyze the determinants of cluster membership by using a set of logistic regression analyses, meaning that we estimate separate logistic regression models for each cluster outcome: the first category versus all others, the second category versus all others, and so on. An alternative strategy would be to use multinomial logistic regression analysis. Within a multinomial framework, however, we would need to specify one cluster outcome as the reference category to which the others are compared. Although both approaches are valid methods, we prefer to use separate logistic regression models because we are primarily interested in the odds of experiencing a certain trajectory type compared to all others, rather than the odds of experiencing one type over one specific other type.

For each cluster outcome, two models are estimated. Model 1 includes only the dummy variables for ethnic origin of the child. We use this model to test Hypothesis 1. In Model 2, we add parental and household characteristics in order to assess the extent to which they explain associations between children's ethnicity and neighborhood trajectories, thus testing Hypothesis 2. Importantly, however, comparisons of logistic regression coefficients of the same variable across nested models can be misleading because the dependent variable is scaled differently in each model (Mood, 2010). We address this issue by using the Karlson–Holm–Breen (KHB) method (see Karlson, Holm, & Breen, 2012). Finally, in order to test Hypothesis 3, we run additional models in which we interact household income with ethnicity. We also include a predicted probability plot to visualize these interaction effects.

4. Results

4.1. Typology of neighborhood trajectories

Since the number of possible sequences is extremely large, we have reduced the entire set of sequences into population subgroups by means of optimal matching followed by cluster analysis. Several cluster solutions were tested, of which the 6-cluster solution was determined to be

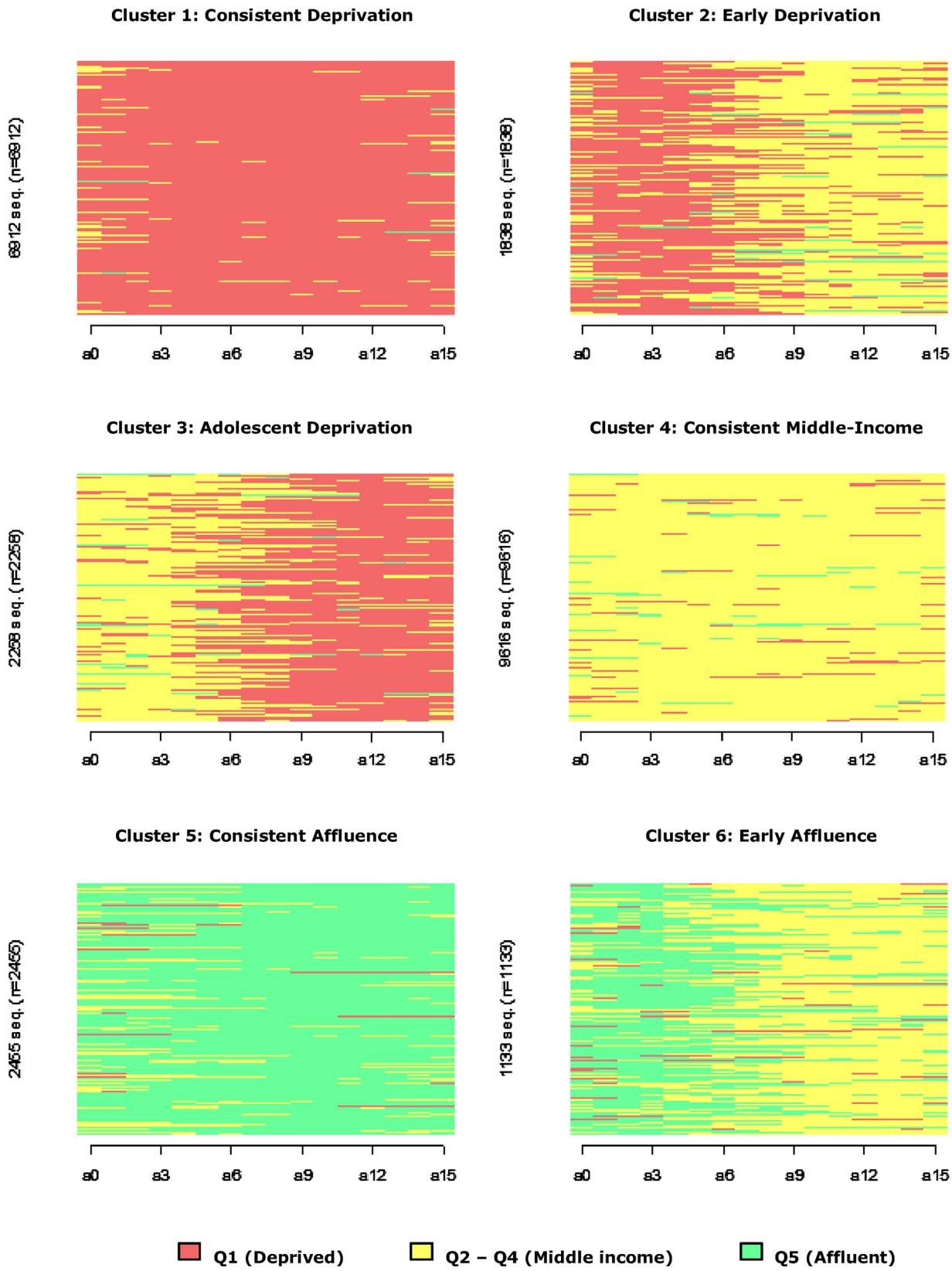

Fig. 1. Sequence index plots of six clusters of children's neighborhood trajectories.

optimal (ASW = 0.47). Fig. 1 shows the sequence index plot for each of the six clusters. In these plots, each individual is represented by a separate horizontal line. The color of the line indicates the type of neighborhood along chronological age – red for deprived, yellow for middle-income, and green for affluent neighborhoods.

Cluster 1 (*consistent deprivation*) is characterized by living in a deprived neighborhood throughout the entire childhood life course. In any given year, more than 85% of the children represented by this

Table 2
Percentage distribution over the neighborhood trajectory clusters, by ethnicity: Column percentages.
Source: System of Social statistical Datasets (SSD).

	Turkish (N = 5598)	Moroccan (N = 5702)	Surinamese (N = 4147)	Antillean (N = 1367)	Dutch (N = 7398)
1. Consistent Deprivation	43.6	41.5	23.3	26.1	10.6
2. Early Deprivation	8.0	8.3	8.9	10.1	5.6
3. Adolescent Deprivation	11.3	11.6	10.0	10.2	5.6
4. Consistent Middle-Income	31.1	31.2	38.3	35.9	54.3
5. Consistent Affluence	3.5	4.9	13.0	12.1	17.3
6. Early Affluence	2.5	2.6	6.5	5.6	6.8
Total	100	100	100	100	100

Note: Percentages may not add to 100 due to rounding.

cluster were living in a low-income neighborhood. This does not necessarily mean that these children had never changed residences during the observation period, but if they moved, they generally moved to neighborhoods similar to those they moved from. Children in cluster 2 (*early deprivation*) were typically born in a deprived neighborhood, but moved towards more affluent neighborhoods as they grew older. Indeed, about 66% of these children were living in a deprived neighborhood at birth, as compared to 11 percent at age 15. Children in cluster 3 (*adolescent deprivation*) followed the opposite path: they were mainly born in middle-income neighborhoods, but increasingly moved towards deprived neighborhoods over the course of their childhood. About 10% of these children lived in a deprived neighborhood at birth, compared to 82% at age 15.

Children in clusters 4–6 all had little exposure to neighborhood disadvantage throughout childhood. Cluster 4 (*consistent middle-income*) comprises children who had lived in middle-income neighborhoods during (almost) the entire childhood life course. Over the complete observation period, more than 88% of these children were living in a middle-income neighborhood. Cluster 5 (*consistent affluence*) is characterized by a long period of living in an affluent neighborhood. For most of the observation, about 80–90% of the children in this cluster were living in an affluent neighborhood, except for the first two years of observation when this was around 65%. Finally, cluster 6 (*early affluence*) predominantly includes children who were living in an affluent neighborhood during early childhood, but who moved towards less affluent neighborhoods as they grew older. For example, about 67% of these children were born in a high-income neighborhood, while only 15% of them lived in an affluent neighborhood at age 15.

4.2. Ethnic differences in neighborhood trajectories

Our main interest lies in ethnic differences in cluster membership. We therefore show the percentage distribution over the clusters for the different ethnic groups separately in Table 2. As can be seen in the table, ethnic minority children more often lived in a deprived neighborhood throughout their entire childhood (cluster 1) than native Dutch children. This is in particular the case for the Turkish and Moroccan children, of which more than 40 percent had been consistently exposed to neighborhood disadvantage during childhood, compared to 11% of native Dutch children. Conversely, the consistent affluent trajectory (cluster 5) was very uncommon among Turkish and Moroccan children, with respectively 4 and 5 percent being grouped in this cluster. Native Dutch children were most frequently exposed to consistent neighborhood affluence (17%). The middle-income trajectory (cluster 4) was common among all ethnic groups, but especially for native Dutch (54%). Finally, regarding the trajectories characterized by a change in neighborhood status, the differences between ethnic groups are relatively small. Children from immigrant families were slightly more often exposed to neighborhood deprivation early (cluster 2) or late (cluster 3) in childhood, while the early affluence trajectory (cluster 6) was more common among native Dutch children.

Next, we model the effects of a range of explanatory variables on cluster membership using a series of logistic regression models. The coefficients and standard errors are reported in Table 3. The first models (under Model 1) include only the dummy variables for the ethnicity of the child. In the next set of models (under Model 2), we added parental and household characteristics. As seen in Table 3, Model 1a–c, children from all ethnic minority groups had higher odds than native Dutch children of classified in one of the three trajectory groups with substantial exposure to neighborhood deprivation during childhood with $p < .001$, thus supporting Hypothesis 1. The differences were largest with regard to the consistent deprivation group; especially Turkish ($b = 2.04$, s.e. = 0.05, $p < .001$, OR = 7.71) and Moroccan ($b = 1.88$, s.e. = 0.05, $p < .001$, OR = 6.58), but also Surinamese ($b = 1.25$, s.e. = 0.05, $p < .001$, OR = 3.48) and Antillean ($b = 1.53$, s.e. = 0.08, $p < .001$, OR = 4.60) children had higher odds of being consistently exposed to neighborhood disadvantage during childhood than native Dutch children. Looking further at Table 3, Model 1d–f, we find that children from all ethnic minority groups less often grew up in middle-income and affluent neighborhoods than native Dutch children with $p < .001$. Out of these three clusters, the differences were largest for the consistent affluence group. Turkish ($b = -2.06$, s.e. = 0.08, $p < .001$, OR = 0.13) and Moroccan ($b = -1.59$, s.e. = 0.07, $p < .001$, OR = 0.20) children again deviated stronger from native Dutch children than Surinamese ($b = -0.87$, s.e. = 0.07, $p < .001$, OR = 0.42) and Antillean ($b = -1.11$, s.e. = 0.10, $p < .001$, OR = 0.33) children.

We proceed by comparing Models 2 to Models 1 in Table 3 in order to assess the extent to which the observed parental and household characteristics account for the ethnic group differences as reported above. In support of Hypothesis 2, all coefficients associated with ethnic origin decrease in magnitude when accounting for parental and household characteristics (Table 3). However, recall that comparing logistic regression coefficients of the same variable across nested models may be problematic due to so-called 'scaling effects' (Mood, 2010). We therefore used the KHB method (Karlson et al., 2012) to estimate the unbiased change in ethnic group differences between Models 1 and 2. The results showed that parental and household characteristics reduced ethnic differences in the odds of cluster membership with $p < .001$ for all trajectory types. Specifically, including these variables was found to reduce ethnic differences by 38 (Surinamese) to 57 (Moroccan) percent for cluster 1; 75 (Antillean) to 104[3] (Turkish) percent for cluster 2; 23 (Moroccan) to 39 (Antillean) percent for cluster 3; 38 (Turkish) to 43 (Antillean) percent for cluster 4; 49 (Turkish) to 64 (Moroccan) percent for cluster 5; and 58 (Turkish) to 74 (Moroccan) percent for cluster 6. Comparing the relative mediating power of each variable, we found that household income is by far the most important mediator. Thus, household income is the most important observed factor in explaining ethnic differences in children's

[3] Table 3 shows that the positive coefficient for Turkish ethnicity in Model 1b (b = -0.42, s.e. = 0.07, $p < .001$, OR = 1.52) becomes slightly negative in Model 2b (b = -0.02, s.e. = 0.09, $p = .843$, OR = 0.98). The coefficient is thus not only reduced, but also reversed, which explains the 104 percent reduction.

Table 3
Logistic regression analyses of neighborhood trajectory clusters on ethnicity: Logit coefficients.
Source: System of Social statistical Datasets (SSD).

	Cluster 1: Consistent Deprivation				Cluster 2: Early Deprivation				Cluster 3: Adolescent Deprivation			
	Model 1a		Model 2a		Model 1b		Model 2b		Model 1c		Model 2c	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Ethnic group (ref = Dutch)												
Turkish	2.04***	0.05	1.17***	0.06	0.42***	0.07	−0.02	0.09	0.80***	0.07	0.58***	0.08
Moroccan	1.88***	0.05	0.86***	0.06	0.44***	0.07	0.08	0.09	0.82***	0.07	0.66***	0.09
Surinamese	1.25***	0.05	0.82***	0.06	0.57***	0.08	0.11	0.09	0.70***	0.08	0.45***	0.09
Antillean	1.52***	0.08	0.86***	0.09	0.73***	0.11	0.18	0.12	0.74***	0.11	0.44***	0.12
Mixed parentage (ref = no)	−0.85***	0.04	−0.56***	0.05	−0.15*	0.07	−0.16*	0.07	−0.16*	0.06	−0.21**	0.06
Father's educational level (ref = low/med)												
High			−0.14**	0.05			−0.12	0.08			−0.03	0.07
Unknown			−0.04	0.04			0.08	0.06			0.05	0.05
Mother's educational level (ref = low/med)												
High			−0.07	0.05			−0.02	0.07			−0.01	0.07
Unknown			−0.01	0.04			−0.04	0.06			−0.05	0.05
Father's labor force participation			−0.05	0.05			0.18*	0.09			0.01	0.08
Mother's labor force participation			−0.19***	0.05			0.21*	0.09			−0.12	0.08
Log household income			−0.78***	0.05			−0.36***	0.07			−0.21**	0.06
Parents homeowners (ref = rented)			−0.40***	0.04			−0.30***	0.07			0.01	0.06
Residential mobility (ref = 0 moves)												
1 move			−0.45***	0.04			0.97***	0.07			0.46***	0.06
2 moves			−0.53***	0.05			1.17***	0.08			0.75***	0.07
≥3 moves			−0.86***	0.07			1.49***	0.09			1.09***	0.08
Household size			0.13***	0.01			0.04*	0.02			−0.02	0.02
Parental union status (ref = stable union)												
Never lived together			0.14*	0.07			0.16	0.10			0.04	0.10
Dissolution			−0.09*	0.04			−0.17	0.07			0.16**	0.06
Started living together			0.11	0.09			0.21*	0.12			0.18	0.12
Age difference with father			−0.01**	0.00			−0.01*	0.01			−0.01	0.01
Age difference with mother			−0.03***	0.00			−0.01	0.01			−0.01	0.01
Constant	−2.14***	0.04	−0.31*	0.14	−2.83***	0.05	−2.83***	0.22	−2.83	0.05	−2.50***	0.21
Pseudo R^2	0.10		0.15		0.01		0.05		0.01		0.04	

	Cluster 4: Consistent Middle-Income				Cluster 5: Consistent Affluence				Cluster 6: Early Affluence			
	Model 1d		Model 2d		Model 1e		Model 2e		Model 1f		Model 2f	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Ethnic group (ref = Dutch)												
Turkish	−1.05***	0.04	−0.66***	0.05	−2.06***	0.08	−1.06***	0.10	−1.21***	0.10	−0.52***	0.12
Moroccan	−1.01***	0.04	−0.59***	0.05	−1.59***	0.07	−0.59***	0.09	−1.11***	0.10	−0.30*	0.12
Surinamese	−0.81***	0.04	−0.50***	0.05	−0.87***	0.07	−0.40***	0.08	−0.35***	0.09	−0.12	0.10
Antillean	−0.97***	0.07	−0.57***	0.04	−1.11***	0.10	−0.62***	0.12	−0.58***	0.14	−0.25	0.15
Mixed parentage (ref = no)	0.38***	0.04	0.27***	0.04	1.06***	0.07	0.77***	0.07	0.62***	0.09	0.32***	0.09
Father's educational level (ref = low/med)												
High			0.06	0.04			0.08	0.06			0.02	0.09
Unknown			0.01	0.03			−0.05	0.06			0.07	0.07
Mother's educational level (ref = low/med)												
High			0.00	0.04			0.05	0.06			0.03	0.08
Unknown			0.02	0.03			0.07	0.06			0.00	0.07
Father's labor force participation			0.32***	0.05			0.36**	0.10			0.33*	0.14
Mother's labor force participation			0.29***	0.05			0.06	0.07			0.23*	0.10
Log household income			−0.03	0.04			1.32***	0.06			0.49***	0.08
Parents homeowners (ref = rented)			0.20***	0.04			0.14*	0.06			0.24**	0.08
Residential mobility (ref = 0 moves)												
1 move			−0.24***	0.03			0.32***	0.05			0.54***	0.08
2 moves			−0.33***	0.05			0.10	0.08			0.75***	0.10
≥3 moves			−0.47***	0.06			−0.13	0.10			1.07***	0.11
Household size			−0.05***	0.01			−0.09***	0.02			−0.10**	0.03
Parental union status (ref = stable union)												
Never lived together			−0.19**	0.06			−0.02	0.13			0.13	0.16
Dissolution			0.01	0.04			0.05	0.07			0.19*	0.09
Started living together			−0.17*	0.08			−0.30	0.15			0.34*	0.16
Age difference with father			0.00	0.00			0.02***	0.01			0.00	0.01
Age difference with mother			0.01*	0.00			0.05***	0.01			0.03**	0.01
Constant	0.17***	0.04	−0.59***	0.13	−1.57***	0.03	−3.99***	0.23	−2.62***	0.05	−4.69***	0.31
Pseudo R^2	0.03		0.05		0.08		0.15		0.03		0.06	

Note: *** $p < .001$; ** $p < .01$; * $p < .05$.

Table 4
Interaction effects between log household income and ethnicity: Logit coefficients.
Source: System of Social statistical Datasets (SSD).

	Consistent Deprivation		Consistent Middle-Income		Consistent Affluence	
	Coef.	SE	Coef.	SE	Coef.	SE
Ethnic group (ref = Dutch)						
Turkish	1.15***	0.06	−0.73***	0.05	−0.89***	0.11
Moroccan	0.86***	0.06	−0.65***	0.05	−0.47***	0.10
Surinamese	0.76***	0.06	−0.61***	0.05	−0.19*	0.10
Antillean	0.79***	0.09	−0.69***	0.07	−0.65***	0.15
Log household income (mean centered)	−1.29***	0.09	−0.37***	0.05	1.55***	0.08
HH income × Turkish	0.70***	0.11	0.77***	0.08	−0.46**	0.17
HH income × Moroccan	0.71***	0.11	0.61***	0.08	−0.80***	0.15
HH income × Surinamese	0.50***	0.12	0.35***	0.08	−0.49***	0.12
HH income × Antillean	0.39*	0.15	0.45***	0.11	0.12	0.20
Constant	9.35***	0.67	2.37***	0.40	−15.79***	0.61
Pseudo R2	0.15		0.05		0.16	

Note: *** p < .001; ** p < .01; * p < .05.
Included are controls for mixed parentage, parental educational level, parental labor force participation, housing tenure, residential mobility, household size, parental union status, and age difference with parents (coefficients not presented).

neighborhood status. Full details of the KHB decomposition analysis can be found in Supplementary data Appendix C. All in all, we thus find strong support for our second hypothesis that ethnic differences in children's neighborhood trajectories are partially mediated by parental and household characteristics.

4.3. Household income by ethnicity

In order to test our third and last hypothesis, we interact the effect of household income on children's neighborhood trajectories by ethnicity. For these analyses, we focus on the three clusters in which children's neighborhood status remained stable over time, i.e. consistent deprivation (cluster 1), consistent middle-income (cluster 4), and consistent affluence (cluster 5). The reason for this is that household income is averaged out over the observation period, which makes it more difficult to interpret its effect on neighborhood trajectories that are characterized by change. Table 4 displays logistic regression coefficients and standard errors from the three models interacting household income with ethnicity. Note that our measure of logged household income is centered around the mean, which implies that the main effects of ethnicity in Table 4 are similar to those in Model 2 of Table 3 (Snijders & Bosker, 1999). To facilitate interpretation, we also visualize the interaction effects between household income and ethnicity in Fig. 2. Specifically, we plot predicted probabilities of cluster membership, for each ethnic group separately, for five values of mean-centered log household income: −1.5 (close to the minimum); −0.5; 0.5; 1.5; and 2.5 (close to the maximum). Confidence intervals are not presented in the figure because the 95% CI are indistinguishable at certain values.

As can be seen in the top graph of Fig. 2, we find a negative effect of household income on consistent exposure to neighborhood disadvantage for all groups, but the effect is stronger for native Dutch children than for ethnic minority children. Supporting this finding, as shown by Table 4, we find a negative effect of household income on the odds of consistent deprivation for native Dutch children ($b = -1.29$, s.e. = 0.09, $p < .001$, OR = 0.27) with positive interaction terms for Turkish ($b = 0.70$, s.e. = 0.11, $p < .001$, OR = 2.00), Moroccan ($b = 0.71$, s.e. = 0.11, $p < .001$, OR = 2.03), Surinamese ($b = 0.50$, s.e. = 0.12, $p < .001$, OR = 1.64), and Antillean ($b = 0.39$, s.e. = 0.15, $p = .011$, OR = 1.48) children. As regards the consistent affluence group, we find the opposite trend. The bottom graph in Fig. 2 shows that the positive effect of household income on consistent exposure to neighborhood affluence is stronger for native Dutch children than for ethnic minority children, although the Antillean group is very similar to the native Dutch. Indeed, as can be seen in Table 4, we find a positive effect of household income for native Dutch children ($b = 1.55$, s.e. = 0.08, $p < .001$, OR = 4.73) with negative interaction terms for Turkish ($b = -0.46$, s.e. = 0.17, $p = 0.007$, OR = 0.63), Moroccan ($b = -0.80$, s.e. = 0.15, $p < .001$, OR = 0.45), and Surinamese ($b = -0.49$, s.e. = 0.12, $p < .001$, OR = 0.61) children. The Antillean group does not differ from the native Dutch in this regard ($b = 0.12$, s.e. = 0.20, $p = 0.559$, OR = 1.12).

Finally, regarding the consistent middle-income group, we find that the effects of household income for the different ethnic groups differ in direction. Specifically, the middle graph in Fig. 2 shows a negative effect of household income for native Dutch children, a positive effect for Turkish and Moroccan children, and almost no effect for Surinamese and Antillean children. Indeed, the findings in Table 4 show positive interaction terms for Turkish ($b = 0.77$, s.e. = 0.08, $p < .001$, OR = 2.15) and Moroccan ($b = 0.61$, s.e. = 0.08, $p < .001$, OR = 1.85) children that are larger in magnitude than the negative coefficient of household income for native Dutch children ($b = -0.37$, s.e. = 0.05, $p < .001$, OR = 0.69). The positive interaction terms for Surinamese ($b = 0.35$, s.e. = 0.08, $p < .001$, OR = 1.42) and Antillean ($b = 0.45$, s.e. = 0.11, $p < .001$, OR = 1.56) children are about equal to the negative effect for native Dutch children. In other words, Turkish and Moroccan households with higher incomes more often reside in middle-income neighborhoods than those with lower incomes. For native Dutch households, however, this pattern is the other way around. For Surinamese and Antillean families, we do not find a strong effect of income on their odds of residing in middle-class neighborhoods. Thus, nearly all these findings provide support for Hypothesis 3, namely that the impact of household income on children's neighborhood income trajectories differs by ethnicity.

5. Discussion

A growing body of literature recognizes that what matters for children is not only their current residential location, but also their past neighborhood experiences (Sharkey & Faber, 2014). Research has therefore increasingly accounted for the duration of exposure to deprived neighborhoods during childhood, rather than measuring children's neighborhood status at a single point in time (Timberlake, 2007). However, whilst these cumulative measures of exposure are undoubtedly more accurate representations of children's long-run neighborhood environment than single point-in-time assessments, a sole focus on duration of exposure does not provide information on whether neighborhood disadvantage occurs early or later in childhood, i.e. the timing of exposure. This is unfortunate as accounting for the timing of

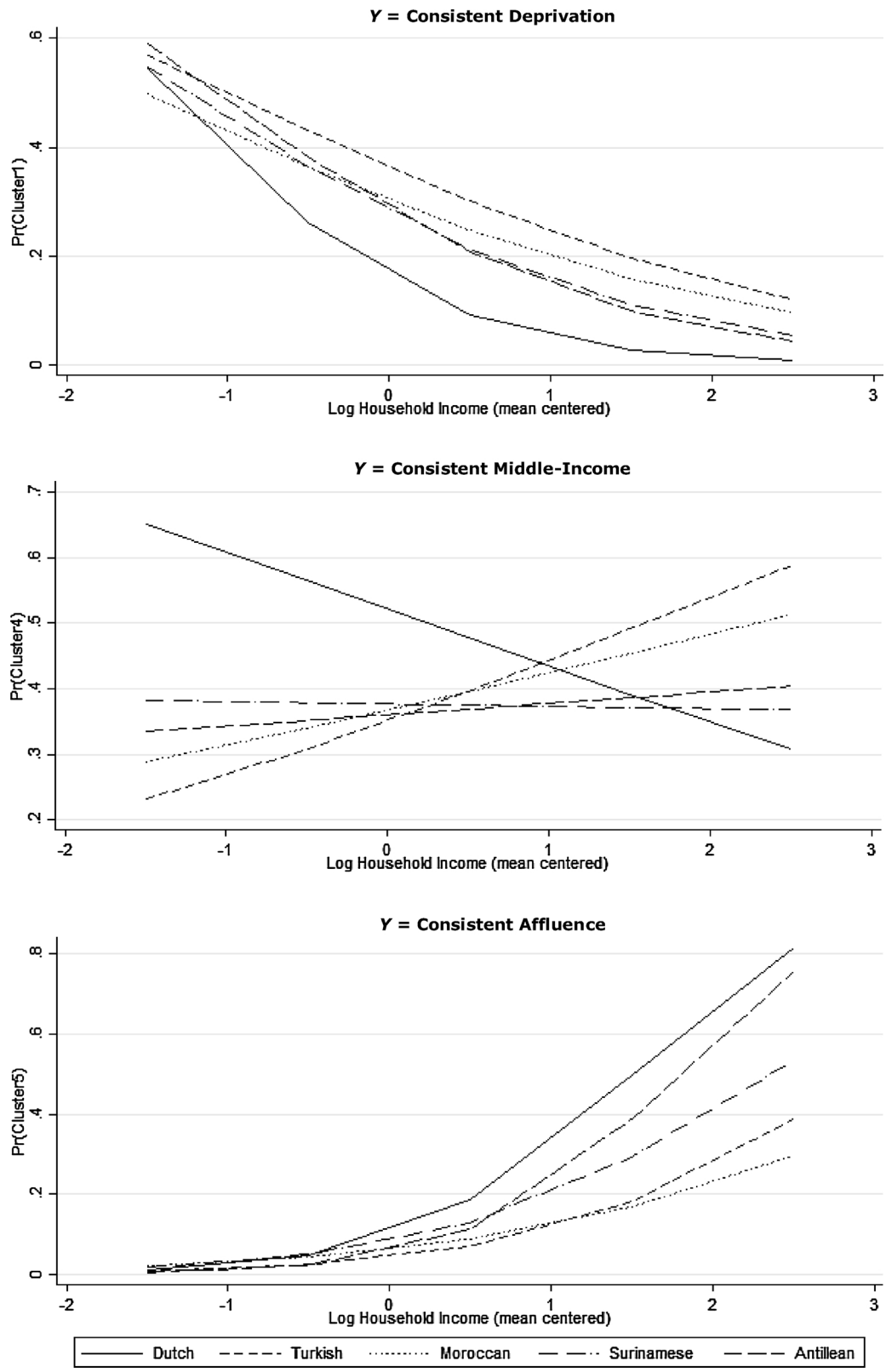

Fig. 2. Predicted probabilities of cluster membership for different values of mean-centered log household income by ethnicity (confidence intervals are not presented for clarity).

exposure to neighborhood disadvantage provides insights into who moves up and who moves down the neighborhood hierarchy. Moreover, previous research has shown heterogeneous effects for neighborhood disadvantage during early childhood versus adolescence on children's outcomes in later life (Wodtke, 2013). In this study, we applied sequence analysis to simultaneously take into account timing and duration of exposure to poor and nonpoor neighborhoods during childhood, thus providing a much more comprehensive view on children's neighborhood histories. We specifically focused on ethnic differences in patterns of exposure to neighborhood (dis)advantage during

childhood, comparing the children of the four largest non-Western immigrant groups in the Netherlands (Turks, Moroccans, Surinamese, and Antilleans) with native Dutch children.

The sequence analysis indicated that children's neighborhood trajectories followed one of six general patterns. In three of these patterns, children had lived in a deprived neighborhood at some point during childhood, but the patterns differed in terms of timing and duration of exposure. Some children experienced neighborhood disadvantage throughout childhood (consistent deprivation), while other children were exposed to a deprived neighborhood either only early in childhood (early deprivation) or only during adolescence (adolescent deprivation). In the three other types, children thus had little exposure to neighborhood disadvantage. Some children lived in a middle-income neighborhood throughout childhood (consistent middle-income), others consistently lived in an affluent neighborhood during childhood (consistent affluence), and still others moved from an affluent neighborhood towards a middle-income neighborhood (early affluence).

These different types of neighborhood trajectories highlight important advantages of our sequence analysis approach over more conventional measures of neighborhood disadvantage, such as point-in-time and cumulative measures of exposure. For example, by measuring neighborhood disadvantage at a single point in time in childhood (e.g., age 15), researchers conflate relatively recent exposure to neighborhood disadvantage (adolescent deprivation) with that of long-term neighborhood disadvantage (consistent deprivation). In contrast, by solely focusing on the duration of exposure to neighborhood disadvantage in childhood, researchers conflate early exposure (early deprivation) with later exposure to neighborhood disadvantage (adolescent deprivation). We encourage future research to explicitly take into account such dynamics where possible. This can shed more light on the importance of residential neighborhoods for child and adolescent development, which remains a much debated issue in the academic literature (Pebley & Sastry, 2004).

Interestingly, children moving from middle-income to affluent neighborhoods did not form a separate cluster in our analysis. This does not mean that none of the children followed such a neighborhood trajectory, but rather that the group was not large enough to form a cluster on its own. The absence of such a cluster is likely related to the large share (70%) of non-Western ethnic minorities in our research population, which typically live in poorer neighborhoods than the native Dutch (more on this later). Indeed, the clusters characterized by exposure to deprived and middle-income neighborhoods were substantially larger than those with exposure to neighborhood affluence. Another interesting finding in this regard was that the clusters in which children's neighborhood status remained stable over time were clearly larger than the clusters including changes in children's neighborhood status. In addition, the sequence analysis did not identify a cluster characterized by more complex patterns, such as repeatedly moving in and out of deprived neighborhoods. These findings highlight a rather strong path dependence in children's neighborhood trajectories, i.e. many children stay in the same type of neighborhood as the one that they were born in during their entire childhood (Kleinepier & van Ham, 2017). Further analysis showed that this was also the case when using very small spatial scales (100 × 100 m grids) to define neighborhoods, which are often most prone to change. Our findings are at odds with studies showing that many families move in an effort to find better neighborhoods for their children (Pebley & Sastry, 2004). Again, this may be related to the large share of ethnic minorities in our research population, which generally have more difficulty in finding upward residential mobility than other groups.

In line with this, we found that ethnic minority children (especially Turkish and Moroccan children) had higher odds than native Dutch children to live in poor neighborhoods at any specific stage within childhood, but particularly throughout childhood. About four out of ten Turkish and Moroccan second-generation children had experienced long-term neighborhood disadvantage during childhood, as compared to only about one out of ten native Dutch children. The main objective of the regression analyses was to examine the extent to which ethnic differences in children's neighborhood trajectories could be explained by parental and household resources. In accordance with spatial assimilation theory, ethnic differences indeed became substantially smaller after accounting for these variables. For the group moving out of deprived neighborhoods (i.e., early deprivation), differences between the ethnic minority children and the native Dutch fully disappeared after controlling for family socioeconomic background. However, for the other trajectory types (especially the consistent deprivation and affluence groups), a substantial unexplained difference between native Dutch and ethnic minority children remained.

One possible explanation for the residual ethnic differences in children's neighborhood trajectories could be data limitations. Although the register data we used entail important advantages over survey data, they do not provide information on several factors that might be decisive for immigrants' neighborhood attainment, for example their Dutch language proficiency, knowledge of the Dutch housing market, and social networks (e.g., experiences from family and friends on how to get access to housing in more affluent neighborhoods). Furthermore, while we have information on household income, we have no information on household debts and savings, which are important for access to housing in more attractive residential areas as well. Finally, the data on parental educational level were incomplete, particularly among ethnic minority groups. We thus likely underestimated the relevance of the spatial assimilation theory.

However, the last part of our analysis showed that the effect of household income on children's neighborhood trajectories differed by ethnic group. For example, the negative effect of household income on consistent exposure to neighborhood disadvantage was more negative for native Dutch children than for ethnic minority children. We also found a positive effect of household income on residence in middle-income neighborhoods for Turkish and Moroccan children, a negative for native Dutch children, and almost no effect for Surinamese and Antillean children. These findings suggest that immigrant families do not have the same 'locational returns' from their economic resources as do native Dutch families. Particularly Turkish and Moroccan families appear to profit less from higher incomes than native Dutch families in terms of neighborhood quality. This is in contrast to the key expectation of the spatial assimilation hypothesis, meaning that ethnic differences in neighborhood quality are likely not solely related to differences in family socioeconomic resources.

We proposed two alternative explanations for the unexplained differences in the neighborhood trajectories of native Dutch and ethnic minority children and the differential effect of household income on children's neighborhood trajectories. First, drawing upon theories of place stratification, it is possible that ethnic minorities have limited access to nonpoor neighborhoods due to discriminatory practices by lenders, realtors, and homeowners. Second, it might it also be that immigrant families prefer to live in a neighborhood with at least a substantial number of coethnics and/or ethnic-specific facilities, which generally have a lower average family income than neighborhoods dominated by the ethnic majority population. Unfortunately, with the data at hand we could not confirm if either of these alterative explanations were correct. Nevertheless, qualitative research revealed that ethnic minorities in the Netherlands experienced no discrimination on the housing market, while many of them mentioned that having a network of family or friends close by is important (Kullberg et al., 2009). In addition, as mentioned before, we found no ethnic differences in moving out of poverty neighborhoods (early deprivation) after accounting for parental and household characteristics, while a substantial ethnic residual remained for moving into poverty neighborhoods (adolescent deprivation). Crowder and South (2005) argue that moving into poor neighborhoods may in large part be voluntary mobility, whereas discrimination is mainly a barrier for moving out of poor areas. Thus, if discrimination would be primarily responsible for ethnic

differences in neighborhood status, we would expect to find a large unexplained ethnic gap for moving out of poor neighborhoods, and not the other way around. This potentially suggests that ethnic differences in neighborhood attainment are more likely to result from immigrants' desires to live with coethnics than from discrimination, but more research is needed to test this.

Although the advantages of using sequence analysis to assess children's exposure to neighborhood deprivation are apparent, it is not without limitations either. Because sequence analysis focuses on the comparison of whole trajectories, it does not allow for the inclusion of time-varying covariates. We therefore averaged out several time-varying characteristics of the family (e.g., household income) over the observation period, which to a large extent disregards the longitudinal dimension of these predictor variables (Timberlake, 2009). This limitation was most pronounced when predicting cluster membership for clusters involving changes in neighborhood status, because such changes are likely to go hand in hand with changes in household income and/or parental employment status (Morris, 2017). For example, an income of €5000 at t0 and €10,000 at t1 has the same average as an income of €10,000 at t0 and €5000 at t1, but the likelihood of moving up or down the neighborhood hierarchy differs substantially between these two hypothetical situations. An alternative strategy would be to use multichannel sequence analysis to simultaneously model children's exposure to both neighborhood and family economic deprivation. However, using this approach, we would not be able to assess the extent to which ethnic differences in children's neighborhood trajectories are related to differences in household income, nor could we examine whether the effect of household income on children's neighborhood trajectories differs by ethnicity.

Overall, this study contributes to the existing literature on children's neighborhood environment in at least two ways. First, this is one of the first European studies examining ethnic differences in children's neighborhood environment. We showed that family socioeconomic resources are important for explaining ethnic differences in children's neighborhood trajectories, supporting the spatial assimilation hypothesis. However, our study also strongly suggests that other unobserved factors account for differences across ethnic groups, supporting theories on place stratification and/or residential preferences. Future research should aim to examine the relative importance of housing market discrimination versus residential preferences in explaining ethnic differences in neighborhood attainment in the European context. Second, our study represents one of the few empirical analyses that capture both timing and duration of exposure to neighborhood disadvantage during childhood. The findings showed important differences between children with similar durations of exposure to neighborhood disadvantage depending on the timing of exposure (i.e., early and adolescent deprivation group). This is a fruitful starting point for future research to develop a greater understanding of the causes and consequences of exposure to neighborhood disadvantage during childhood.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.alcr.2018.04.003.

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