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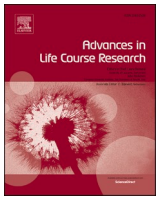

Life-course social connectedness: Comparing data-driven and theoretical classifications as predictors of functional limitations in adulthood

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ABSTRACT

A life course perspective on social relationships highlights the importance of specific relationships at specific times in life, but analyses that account for life course trajectories in social relationships are rare. This study compares theoretical and data-driven approaches to classifying life course relationships, including multiple dimensions of social connectedness at different time points across the life course. We examine each approach's ability to predict later-life functional limitations, given that functional impairment is prevalent among middle-aged and older adults. Data were from three waves of the Midlife in the United States (MIDUS) study (n = 6909). Relationship variables (parental affection, parental discipline, social support, social strain, and positive relations with others) were from wave 1 or wave 2. Functional limitations were measured at wave 3. Results showed that the data-driven approach had more predictive power than the theoretical approach. Additionally, results suggested that including only positive relationship features was nearly as robust as including both positive and negative relationship features. Overall, the data-driven approach outperformed the theoretical approach and revealed relationship trajectories consistent with life course cumulative processes.

1. Introduction

Social relationships are consistently and robustly associated with physical (Berkman & Seeman, 1986; Cacioppo & Cacioppo, 2014; Holt-Lunstad et al., 2010) and psychological (Santini et al., 2015; Umberson et al., 1996) well-being. However, the current approach to studying social relationships and health tends to be piecemeal, with studies often examining one type of relationship (e.g., spouse, parent), relationship factors of one valence (e.g., positive elements such as social support), or relationships at one point in time (e.g., older adulthood). Our understanding of social relationships and health could be improved by determining how multiple important relationships at important times in the life course work together to predict later-life health outcomes. A life course perspective on social relationships highlights the salience of specific types of relationships at specific times in life. Using a life course perspective, the present study examines three analytic approaches for classifying life course relationships and how each approach predicts later-life health, specifically functional limitations.

2. Social connections and health

Social connectedness has been linked to longevity and health with associations comparable in magnitude to those for physical inactivity, smoking, and obesity (Holt-Lunstad et al., 2010, 2015). Social relationships in adulthood, such as support from friends, family members, and partners, are linked to diverse health outcomes (Cohen, 2004; Holt-Lunstad et al., 2010; Rook & Charles, 2017; Uchino, 2006). Adult health is also influenced by the quality of earlier social connections. Adverse social experiences in childhood, typically in the context of parent-child relationships, predict poorer mental and physical health in adulthood (Chen et al., 2017). Conversely, greater parental affection in childhood predicts better health in adulthood, and parental warmth can buffer against the adverse health effects of other childhood exposures, including low socioeconomic status (Chen et al., 2017).

For the purposes of examining the health correlates of life course social connections, we focus specifically on functional impairment in middle and later life, an increasingly prevalent health concern among

Abbreviations: PRWO, positive relations with others; LPA, latent profile analysis; MIDUS, Midlife in the United States; SAQ, self-administered questionnaire; AIC, Akaike Information Criteria; BIC, Bayesian Information Criterion; SSA-BIC, sample-size adjusted BIC; LMR Adj-LRT, Lo-Mendel-Rubin Adjusted likelihood ratio test; BLRT, Bootstrapped Likelihood Ratio Test; BCH, Bolck-Croon-Hagenaars.

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middle-aged and older adults (Centers for Disease Control and Prevention, 2020). Functional limitations refer to restrictions in performing basic daily activities (e.g., climbing stairs; Verbrugge & Jette, 1994). Specific to the present study, social relationships are frequently associated with functional capacity. Over a 16-year period, participants with high or increasing levels of social engagement accumulated fewer physical limitations over time than participants who were less socially engaged (Thomas, 2011). In another study, perceptions of high social support and low social strain were associated with less decline in functional health over a period of 8–10 years (Lachman & Agrigoroaei, 2010). Among married couples, an individual's own positive marital quality and their spouse's positive marital quality were both associated with less disability onset for the individual over time (Choi et al., 2016).

2.1. Theoretical foundation

The current study brings a life course lens to the study of social connections and health. The life course perspective (Elder, 1998; Elder et al., 2003; Settersten et al., 2021) is a framework for understanding the human life course and consists of five paradigmatic principles: linked lives, timing, historical time and place, human agency, and lifespan development. The principles of timing and lifespan development are particularly relevant for the present study. The principle of *timing* emphasizes the importance of when life events occur, how the consequences of those events may vary based on their timing in a person's life, and the particular significance of early-life experiences (e.g., "the long arm of childhood", or the early origins of later-life outcomes; Chen et al., 2017; Haas, 2008; Hayward & Gorman, 2004; Lee et al., 2019). For example, developmentally it may be more important to have warm, supportive parental relationships in childhood than it is to have them in adulthood. The principle of *lifespan development* emphasizes that human development is a lifelong process, extending from birth to death. Moreover, each phase of life (e.g., adolescence, young adulthood, middle age) is unique and significant, and each includes gains as well as losses. Prior stages and relationships (or relationship transitions) can influence similar or different types of relationships in subsequent phases of life. The life course principles of timing and lifespan development guide the present study in its focus on typologies of social connections across different life stages (e.g., childhood, adulthood) and across different types of relationships (e.g., parent-child; romantic; friendships).

Leveraging the principles of timing and lifespan development, the cumulative (dis)advantage model describes two mechanisms by which childhood experiences can impact later-life outcomes. Experiences and exposures can accumulate over the life course, resulting in trajectories of overall good or overall bad experiences (i.e., accumulation effects; Ferraro & Morton, 2018; Lee & Park, 2020; Thomas et al., 2022a; Umberson & Montez, 2010). Early life experiences may also constrain the range of possible later experiences or provide more opportunities for positive experiences (i.e., contingency effects; Erickson & Macmillan, 2018; Ferraro & Morton, 2018). The cumulative (dis)advantage model will guide interpretation of the social relationship groups developed in the current study.

For clarity, the focus of this paper is social connectedness, a term that acknowledges diversity in conceptions and measures of social relationships. Consistent with the life course perspective and the cumulative (dis)advantage model, we focus specifically on age-relevant social connections at two points in the life course – parental relationships in childhood and multiple aspects of social connectedness in adulthood – to create life course typologies of social connectedness. Life course typologies of social connectedness that incorporate social relationships at multiple time points can help uncover unique patterns across time to further our understanding of the association between social relationships and health.

2.2. Diversity in types and quality of social connections

There are many formulations of social connectedness in existing literature, but they broadly sort themselves into three categories: structure, function, and quality (Holt-Lunstad, 2018). Most studies examining links between social connections and health have focused on structure and function. Structurally, social integration – having multiple points of connection to one's community (e.g., being married; number of friends; memberships in community organizations) – is associated with better health and greater longevity (Berkman et al., 2000; Holt-Lunstad et al., 2010). Social support (both perceived and received) is the most commonly assessed functional dimension of social connectedness, and support from family, friends, and/or partner has been widely shown to predict better health (Shor et al., 2013; Uchino, 2006). Less examined are the ways in which the quality of social connections is linked to health (Holt-Lunstad, 2018), and most studies to date have focused on the quality of marital relationships specifically; these have typically shown that better marital quality predicts better overall health (Robles et al., 2014; Ryan et al., 2014). Fewer studies have probed the quality of other types of relationships as a correlate of adult health. Those that have suggest a positive association between good relationship quality and better health (Rook & Charles, 2017). One aim of the current study is to advance our understanding of links between the quality of social connections in particular and adult health. To this end, in addition to assessing social support and strain in adulthood (measures of both function and quality), we also assess positive relations with others (PRWO), a dimension of eudaimonic well-being (Ryff, 1989; Ryff & Keyes, 1995) capturing the extent to which people report having warm, committed, and trusting relationships with others.

Social connections can also be both positive and negative, and poor-quality social relationships can have adverse effects on health and can be a significant source of stress (Rook & Charles, 2017). Negative aspects of social relationships, such as conflict and strain, have harmful effects on physiological markers, morbidity, and mortality (see Brooks & Dunkel Schetter, 2011 for a review). In this study, we conceptualize "negative" features of social relationships as including social strain and parental discipline. We use this terminology because the bulk of the literature shows that social strain and parental discipline – specifically, harsh, physical, and overreactive discipline – have a wide range of negative outcomes (Mackenbach et al., 2014; Rook, 2015; Weiss et al., 1992). However, we acknowledge these relationship dimensions are not unequivocally detrimental for health and sometimes, counterintuitively, demonstrate positive health effects. For example, appropriate (as opposed to harsh, physical, or overreactive) discipline is positive for development and establishing boundaries in parent-child relationships (Grusec et al., 2017; Sege & Siegel, 2018). Additionally, in a nationally representative sample, higher levels of both social support and strain were associated with greater physical activity and better cognitive health (Thomas et al., 2022a, 2022b).

Moreover, the effects of positive aspects of social relationships may depend on negative aspects, and vice versa. For example, positive features of relationships, such as social support, can buffer the detrimental effects of strained social interactions (Fiori et al., 2012; Walen & Lachman, 2000). Similarly, harsh parenting and high parental discipline seem to be more harmful when parental warmth is low (Beckmann, 2021; South & Jarnecke, 2015; Wang, 2019).

Positive aspects of social relationships can also buffer the impact of other negative influences on health. For example, maternal warmth during childhood has been shown to buffer the negative effects of childhood adversity (e.g., low socioeconomic status) on later-life immune function (Chen et al., 2011). Collectively, this work highlights the complexity of the association between social connections and health and the importance of examining both positive and negative relationship characteristics over time.

2.3. Classifying life course relationships

A snapshot of social relationships is often not sufficient to understand the influence of social connectedness across the life course on health and well-being. Indeed, both childhood and adulthood social relationships are important for health in adulthood as outlined by the timing principle. However, few studies have examined social relationships across the life course as a predictor of adult health outcomes (see Singer & Ryff, 1999 and Yang et al., 2016 for some exceptions).

Creating groups, or typologies, of life course relationships can be advantageous because they allow researchers to move beyond examining single relationship attributes (e.g., social support) experienced at one or more point(s) in time, to capture the patterning of relationship experiences across multiple dimensions (e.g., positive and negative relationship characteristics) and multiple time points (e.g., childhood and adulthood). This approach is consistent with the call for person-oriented (as opposed to variable-oriented) analytic approaches (e.g., Lindwall et al., 2017). In general, a variable-oriented analysis is less able to capture the push and pull of different characteristics, experiences, or exposures of the person and how these patterns give rise to specific behaviors or health outcomes.

Person-centered approaches may be particularly informative when it comes to studying relationships (Whiteman & Loken, 2006). Consideration of both positive and negative relationship characteristics often predict health independently or above and beyond direct effects of either the positive or the negative characteristics of relationships (Ross et al., 2019). Some studies assess only social support or social strain, but not both, whereas other studies may measure both aspects but emphasize the strength of their independent associations with health outcomes. Although informative, these approaches do not fully capture how positive and negative aspects of relationships might work together to predict physical and psychological health and may miss unique relationship processes that can only be detected when multiple aspects of social relationships are considered together.

2.4. Methods for classifying life course relationships

Assessing social connectedness from a person-centered perspective can be accomplished in different ways. For example, sequence analysis and latent curve models are both sophisticated techniques that have been used to examine life course trajectories of socioeconomic and health factors (Haas, 2008; Pollock, 2007). Broadly, several theoretical (e.g., life course cube; Bernardi et al., 2019) and statistical (e.g., event history analysis, sequence analysis; Piccarreta & Studer, 2019) approaches can be used to classify life course trajectories. These methods often differ in their theoretical concepts and goals (Piccarreta & Studer, 2019). Our aim in this study is to explore the properties of two specific approaches for classifying social relationships: 1) a priori, or theoretical, classification strategies, and 2) latent profile analysis (LPA), in which classifications arise from data patterns. We begin by discussing the strengths and weaknesses of each method.

2.4.1. A priori theoretical classification strategies

One common strategy to classify relationship phenomena across the life course is to create life histories based on predetermined criteria (e.g., Singer & Ryff, 1999; Whiteman & Loken, 2006). Drawing on the support for "long arm" effects (e.g., Lee et al., 2019), the present study includes an examination of the long-term association of childhood relationships with later-life health. Consistent with the cumulative (dis)advantage model, we also examine the accumulation of positive or negative social relationships over the life course and interpret trajectories of life-course social connectedness.

This theoretical approach has some distinct advantages. First, it is generally simple and straightforward to create the groups. Second, because groups are defined based on a theoretical framework, the groupings should be substantively meaningful and relevant to a specific research question. However, there are also disadvantages to this approach. Transforming continuous data into categorical data (e.g., dichotomizing a measure of support into "high" or "low") may lead to valuable information being lost. Additionally, creating groups based on specific relationship dimensions only allows the researcher to focus on a limited number of relationship attributes. For example, if four relationship attributes are dichotomized to "low" or "high", the resulting typology would include 16 groups, often too many for meaningful group comparisons. Further, the theoretical approach requires the researcher to categorize measures into categories that are typically understood as "good" (e.g., high on a positive attribute) or "bad" (high on a negative attribute). However, what we consider negative relationship attributes are not ubiquitously harmful and may even be beneficial in some circumstances, as mentioned above. Given the ambiguity of the role of certain levels and types of negative relationship features (particularly out of context), there is not theoretical ground to dichotomize these negative measures. Thus, the focus of the theoretical approach is necessarily limited to positive relationship features.

The present study uses the life course perspective to create theoretically informed groups from positive relationship attributes. In conceptualizing life course trajectories, and acknowledging heterogeneity in aging (Ferraro, 2018), there are people who may be less advantaged during early life who nevertheless have positive health and social outcomes in later life (and vice versa). The principles of timing and lifespan development might guide researchers to categorize people into consistently high positive relationships (high positive childhood, high positive adulthood), consistently low positive relationships (low positive childhood, low positive adulthood), increasingly positive relationships (low positive childhood, high positive adulthood), and decreasingly positive relationships (high positive childhood, low positive adulthood).

2.4.2. Latent profile analysis

A second approach for creating life course trajectory groups is through latent profile analysis (LPA), which is a technique that allows groups to arise naturally from the data. The assumption underlying LPA is that there exist underlying clusters, or groups, of observations (i.e., people) that have similar values on specified indicators. Indicators can be continuous or categorical, so groups can take on any value rather than a categorical value imposed in the theoretical approach, better preserving the distribution of data. Additionally, the use of LPA does not force the researcher to impose a specific number of profiles or to restrict the number of relationship indicators. Compared to the theoretical approach, including four relationship attributes as indicators does not automatically result in a certain number of profiles, limiting the likelihood that "too many" groups will emerge from the data. Because of this, and since the LPA does not require a priori categorization of measures, the LPA technique permits the inclusion of both positive and negative dimensions of social relationships.

There are some drawbacks associated with LPA. Estimation can become difficult, and potentially meaningless, as the number of profiles grows, particularly if profiles include few individuals. Additionally, LPA can be sample-specific in that the optimal solution in one sample may differ from another sample. This can cast some doubt on the validity of one solution versus another. However, this concern is largely attenuated in the present study by using a large, national sample and input variables that are widely used measures.

2.5. The present study

The present study is framed by the life course perspective and includes consideration of multivalent (both positive and negative) dimensions of social relationships. We examine whether a priori theoretically derived life-course relationship groups and empirically derived (i.e., LPA) profiles similarly predict later-life functional limitations. The a priori theoretically derived groups include only positively valanced relationship features for two main reasons. First, conceptually,

the negatively valanced relationship factors included in this study (parental discipline and social strain) are more ambiguous to interpret and demonstrate mixed findings. Moreover, there is not strong theoretical ground for how to include discipline and strain. As mentioned above, compared to the positive relationship features, there are no clear cutoffs for discipline and strain so we cannot dichotomize them into "low" or "high" values in a meaningful way. Second, the emphasis on positive relationship features is consistent with the focus on relationship quality and the unique buffering effects of positively valanced relationship features. Therefore, we employ two empirical approaches. One LPA consisted of positive relationship measures (i.e., positive LPA) only as a direct comparison to the theoretically defined groups. The second included both positive and negative relationship dimensions (i.e., multivalence LPA) to determine whether including positive and negative valanced measures better predicted functional limitations compared to the positive LPA.

Aim 1 was to assess the utility of data-driven vs. a priori theoretical constructions of life course relationship groups in capturing relationship patterns across the life course, and to compare how the positive LPA profiles and positive theoretical groups predict later-life functional limitations. Aim 2 was to examine potentially different profile characterizations based on the valence of the relationship information included by comparing the multivalence LPA to the positive LPA. In both aims, we examine how each approach predicts later-life functional limitations and if groups differ on a pre-determined set of demographic, health, and childhood environment covariates. Both aims are exploratory, and results will help generate theoretical and methodological insights into our understanding of life-course social connectedness. Specifically, results may inform the conceptualization of social relationships across the life course in future studies as well as broaden our understanding of the association between multiple dimensions of social relationships and later-life health.

3. Method

We used data from the Midlife in the United States (MIDUS) study. MIDUS is a national survey of the physical and mental health of middle-aged and older adults. The first wave of MIDUS data collection (MIDUS 1; $N = 7108$) was completed in 1995–1996, and two follow-up studies (MIDUS 2 and MIDUS 3) were completed in 2004–2006 and 2013–2014, respectively. At MIDUS 1, participants ranged in age from 25 to 74 years. To improve racial/ethnic diversity in the MIDUS cohort, a new sample of African American residents of Milwaukee County, WI ($n = 592$) was recruited at MIDUS 2. Data collection at each wave involved a telephone interview and self-administered questionnaire (SAQ). The present study uses data from all three waves of MIDUS, including the Milwaukee subsample (see Fig. 1).

3.1. Measures

Example items for each main variable are included below, and all items can be found on OSF (social relationship variables in M1 documentation; functional limitations in M3 documentation). Summary tables of each of the variables used in the present study are on pp. 2–8 of the Technical Report on OSF.

3.1.1. Social connectedness

We considered five dimensions of social connectedness, spanning both childhood (parental affection, parental discipline) and adulthood (social support, social strain, positive relations with others).

3.1.1.1. Parental affection and discipline. Parent-child relationships were measured retrospectively at MIDUS 1 (MIDUS 2 for the Milwaukee subsample) using maternal and paternal affection and discipline scales (Rossi, 2001). Maternal affection ($\alpha = .91$) and paternal affection ($\alpha = .93$), as well as maternal discipline ($\alpha = .77$) and paternal discipline ($\alpha = .83$), were assessed separately. The affection scales contained 7 items (e.g., "How much love and affection did [s]he give you?") and the discipline scales comprised 4 items (e.g., "How harsh was [s]he when [s]he punished you?"). Responses ranged from 1 (not at all) to 4 (a lot) for all the discipline items and six of the affection items, while the seventh affection item ranged from 1 (poor) to 5 (excellent) and asked respondents to rate their relationship with each parent during their childhood. Following MIDUS protocol (see M1 documentation on OSF), this item was multiplied by a.75 factorial to maintain continuity with other items. For the present study, we created a parental affection score by averaging the maternal and paternal affection scales; similarly, we created a parental discipline score by averaging the maternal and

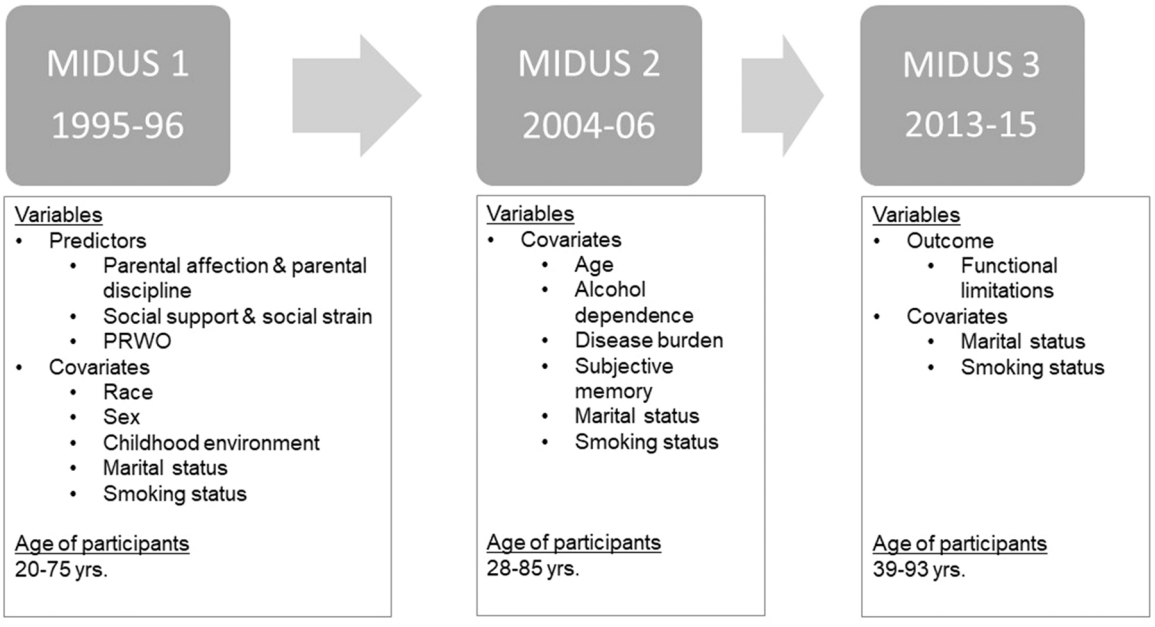

Fig. 1. Timeline of Variables Used and Age of Participants. *Note.* PRWO=positive relations with others. All 3 waves of data were used for the following covariates: adult marital transitions & smoking status.

paternal discipline scales. Scores for parental affection and parental discipline ranged from.96 – 3.96 and 1 – 4, respectively. These scales have previously been used in examination of social relationships as protective factors using MIDUS data (Schuster et al., 1990).

3.1.1.2. Perceived social support and social strain. Participants' social support and social strain were assessed at MIDUS 1 (MIDUS 2 for the Milwaukee sample) across three domains: family, spouse/partner, and friends. Four items were used for both support and strain for family and friends; 6 items were used for support and strain for spouse/partner. Example items for support included "How much can you open up to them if you need to talk about your worries?" and "How much can you rely on them for help if you have a serious problem?". Example items for strain included "How often do they criticize you?" and "How often do they get on your nerves?". Responses ranged from 1 (not at all) to 4 (a lot) and participants' responses to items for support and strain from family, spouse/partner, or friend (6 scales total) were averaged separately (social support range 1.25 – 4; social strain range 1 – 4). Reliability coefficients for family, spouse/partner, and friend support were .84, .90, and .88, respectively. Reliability coefficients for family, spouse/partner, and friend strain were .79, .87, and .79, respectively. Participants' responses related to support and strain were then averaged across domains (i.e., spouse, friends, family) to create one total social support score and one total social strain score, similar to a prior study using MIDUS data showing associations between aggregate measures of social support/strain and health outcomes (Walen & Lachman, 2000).

3.1.1.3. Positive relations with others. Participants also reported on quality of relationships using the 3-item version of the positive relations with others (PRWO; $\alpha = .59$) sub-scale from the Ryff Psychological Well-Being Scales (Ryff, 1989; Ryff & Keyes, 1995). This measure assesses the extent of having satisfying relationships with others (e.g., "I have not experienced many warm and trusting relationships with others" [reverse coded]). Responses ranged from 1 (strongly disagree) to 7 (strongly agree), and item responses were averaged (range 1 – 7).

3.1.2. Functional limitations

In the SAQ at MIDUS 3, all participants were asked how much their health limited their ability to perform a set of eight mobility-related activities (e.g., climbing one flight of stairs). Items were from the Physical Functioning subscale from the SF-36 Health Survey (Ware & Sherbourne, 1992). Item responses (1 =not at all; 4 =a lot) were averaged for each participant (range 1 – 4).

3.1.3. Covariates

Covariates included demographics, health behaviors, adult marital transitions, health conditions, and childhood environment. These specific covariates were chosen based on established associations with social connectedness and/or functional limitations. For example, women (Freedman et al., 2016; Johnson & Wiener, 2006), smokers (Strand et al., 2011), and heavy alcohol users (Cawthon et al., 2007; Moore et al., 2003) are known to be at higher risk for functional limitations in mid- and later-life. Experiencing marital transitions, particularly into widowhood, is also a risk factor for developing limitations (van den Brink et al., 2004). Chronc disease burden (Friedman et al., 2019; Teas et al., 2021) and subjective memory (Blankevoort et al., 2013) are highly positively correlated with functional limitations. Residential instability and parental divorce during childhood are both associated with parent-child relationships (Riina et al., 2016; Zill et al., 1993) and later-life relationships (Amato & Sobolewski, 2001).

3.1.3.1. Demographics. A continuous variable for participants' age was used. Dichotomous variables were used for sex (1 =female), marital status at MIDUS 1 (1 =married), and race (1 =white). We opted to collapse the race variable due to lack of racial diversity; of the participants who did not report being white, about 75% identified as Black.

3.1.3.2. Health behaviors. A dichotomous variable was used to indicate whether participants reported being a smoker at any of the three waves (1 =yes). We used a count variable to represent participants' alcohol dependence at MIDUS 2, which consisted of a sum of 6 potential alcohol problems, similar to Magidson et al. (2017). Four items (e.g., emotional or psychological problems as a result of use, strong desire or urge to drink) were measured dichotomously (1 =yes). Two additional questions (drinking more or using longer than intended and being under the effects of alcohol at work or school) were rated on a 6-point scale (1 [never] to 6 [more than 20 times]), which were dichotomized (0 =never, 1 =all other responses), consistent with the original scoring. The alcohol dependence score ranged from 0 to 6.

3.1.3.3. Adult marital transitions. We created marital transition variables to indicate whether or not they occurred at any point between MIDUS 1 and MIDUS 3. Transitions included divorce, widowhood, and marriage. All three variables were dichotomous (1 =known occurrence). Participants whose marital status did not change or who only had data at MIDUS 1 were coded as 0 for all three variables.

3.1.3.4. Health conditions. Functional decline often results from disease, particularly chronic disease. Burden of chronic medical conditions was assessed using a weighted index (Wei et al., 2016). A total of 26 chronic conditions from the phone survey and SAQ were assigned weights based on their propensity to result in disability, with weights ranging from − .068 for skin cancer to 10.6 for multiple sclerosis; the aggregate weighted score (range: −.068 to 32.912) was used as an index of disease burden. Due to the positive associations between cognitive and functional health (Blankevoort et al., 2013; Sprague et al., 2019; Voelcker-Rehage et al., 2010), we also included subjective assessments of memory. In the MIDUS 2 SAQ, all participants reported how their memory compared to others their age (range: 1–5; 1 =poor, 5 =excellent) and to their own memory 5 years earlier (range: 1–5; 1 =gotten a lot worse, 5 =improved a lot).

3.1.3.5. Childhood environment. Recalled family stability may influence reports of childhood relationships with parents. Similar to prior work (Bures, 2003; Slopen et al., 2017), we created a dichotomous residential instability variable, where residential instability is characterized by $\geq$ 3 no. of times moved to a new neighborhood or town during childhood. We also used dichotomous measures of parental divorce/separation (1 =parents divorced/separated during childhood) and parental death (1 =mother and/or father died during childhood).

3.2. Analytic strategy

We first examined the distribution of all variables and bivariate correlations for variables of interest. We also confirmed linearity of associations between predictors and outcome. The functional limitations outcome variable was positively skewed, and we opted to log transform it to normalize the distribution to meet assumptions of the regression models predicting functional limitations. All code and analytic decisions are available at OSF.

3.2.1. Theory-based groups

As noted above, creating theory-based groups involves dichotomizing each measure into "high" or "low" categories, and then assigning participants into key theoretical groups based on their values of each dichotomized measure. We determined the cutoff point for each measure based on scale items. For example, the response options for the parental affection scale included not at all (1), a little (2), some (3), and a lot (4). We categorized participants as "positive" on the parental

affection measure if their average score was 2.5 or higher, as this would indicate that they mostly reported some or a lot of affection (i.e., the presence of affection). Similar strategies were adopted for each of the relationship measures. See Table 1 for a contingency table for theoretical group assignment.

3.2.2. Latent profile analyses

Mplus software (version 8.8; Muthén & Muthén, 2022) was used to estimate both LPAs. Model parameters were computed using maximum likelihood estimation. For the first aim, the indicator variables for the positive LPA included parental affection, social support, and PRWO to mirror the theoretical approach. For the second aim (multivalence LPA vs. positive LPA), the indicator variables for the multivalence LPA comprised the same positive relationship variables plus parental discipline and social strain.

We estimated the LPAs in several steps to identify the optimal number of latent profiles. We compared a sequence of nested models to determine if more complex models (with more profiles) fit the data better than more parsimonious models (with fewer profiles). We tested models with one to nine profiles. Based on recommendations from prior research, several criteria were used to determine the optimal number of profiles (Henson et al., 2007; Nylund et al., 2007; Ram & Grimm, 2009). The Akaike Information Criteria (AIC), the Bayesian Information Criterion (BIC), and the sample-size adjusted BIC (SSA-BIC) were examined, with lower values indicating better model fit. The Lo-Mendel-Rubin Adjusted likelihood ratio test (LMR Adj-LRT) and the Bootstrapped Likelihood Ratio Test (BLRT) were used to compare the fit of a k-profile solution to a k-1-profile solution, where a statistically significant p-value supports the k-profile solution.

The entropy criterion was examined to assess classification accuracy. Ranging from 0 to 1, a higher entropy value indicates a better fit for a given solution. Although subject to interpretability and theory, a good rule of thumb when judging the usefulness of the profiles is that each latent profile should include at least 5% of the total number of participants (Stanley et al., 2017). The resulting profiles should also make sense theoretically (Lubke & Muthén, 2005), so we examined the mean scores of each of the variables across profiles to assess profile distinctiveness.

3.2.3. Comparison of approaches

We compared a) the positive LPA and theory-based approach (Aim 1) and then b) the two LPAs (Aim 2). Specifically, we examined the composition of groups by creating crosstabs of participant distributions. To assess certain characteristics (e.g., age, sex, childhood environment) of each group, we examined the mean of each covariate for each group for each classification strategy. We used t-tests and chi-squared tests to determine if group means significantly differed from the overall mean.

To determine whether one approach better predicted functional limitations, we modeled the connectedness groups predicting functional limitations, including all covariates, in Mplus. For the theoretical groups, we ran a multiple group analysis. For the LPAs, we used the manual Bolck-Croon-Hagenaars (BCH) method, which accounts for the uncertainty of profile membership (i.e., measurement error) and prevents class shifting when including auxiliary variables (Asparouhov & Muthén, 2014). For all approaches, we used loglikelihood comparisons to determine whether constraining functional limitations across certain classes resulted in a better or worse fitting model. Specifically, we compared the fit statistics of the unconstrained model (i.e., functional limitations mean and variance could differ across each group) to a model in which the functional limitations mean and variance were constrained to be equal across two groups (e.g., profiles 1 and 2); if the constrained model was better fitting than the unconstrained model, this would suggest that functional limitations were not significantly different across profiles 1 and 2. We followed this approach for each combination of groups. The goal was to determine whether one approach was more sensitive in differentiating between groups' predicted functional limitations. In other words, the approach that resulted in more models that could not be constrained based on the functional limitations intercept was judged to be a better predictor of functional limitations.

Table 1
Contingency table of theoretical groups (Aim 3; $n = 6834$).

	Affection		Support		PRWO
Consistently high positive ($n = 5162$)	+	AND	+	OR	+
Consistently low positive ($n = 148$)	-	AND	-	AND	-
Increasing positive ($n = 1426$)	-	AND	+	OR	+
Decreasing positive ($n = 98$)	+	AND	-	AND	-

Note. PRWO = Positive relations with others
Affection + > 2.5, - ≤ 2.5; Support + > 2.5, - ≤ 2.5; PRWO + > 4, - ≤ 4

4. Results

Overall, participants reported moderately high levels of affection (M = 2.98, SD =.65) and discipline (M = 2.94, SD =.60), high levels of social support (M = 3.38, SD =.49), low levels of social strain (M = 2.07, SD =.47), and high levels of PRWO (M = 5.38, SD = 1.37). Most participants reported no or few difficulties with performing daily activities, but almost a third of participants reported at least a few difficulties (functional limitations M = 1.76, SD =.87).

Table 2 shows the descriptive statistics and correlations among the five relationship variables and the functional limitations outcome. Parental affection and discipline were positively correlated ($r = .20$, $p < .001$). Social support was negatively associated with social strain ($r = -.38$, $p < .001$). Among the relationship variables, the only non-significant correlation was between parental discipline and PRWO. All of the relationship variables were significantly correlated with functional limitations. In the following sections, we detail each of the three approaches and their corresponding aim.

4.1. Positive theoretical groups

Using the contingency table described in the Analytic Strategy (Table 1), we assigned participants to a priori determined relationship groups based on their scores on parental affection, social support, and PRWO. This approach resulted in 4 groups. The first group ($n = 5162$), labeled *consistently high positive (*i.e., *high positive)*, was the largest group. Participants who reported low scores for all three relationship dimensions were placed into the *consistently low positive* (i.e., *low positive*) group ($n = 148$). Participants who reported low parental affection but high social support or high PRWO were assigned to the *increasing positive*

Table 2
Correlation table of relationship variables and functional limitations ($n = 6909$).

	Affection	Discipline	Support	Strain	PRWO
Discipline	.20 * **				
Support	.34 * **	.05 * **			
Strain	-0.21 * **	.07 * **	-.38 * **		
PRWO	.28 * **	.01	.46 * **	-.26 * **	
FL	-.05 *	.04 *	-.11 * **	.08 * **	-.09 * **
Mean	2.98	2.94	3.38	2.08	5.38
SD	0.65	.60	.49	.47	1.37
Range	0.96 – 4.0	1 – 4	1 – 4	1–4	1–7

Note. PRWO = positive relations with others; FL = functional limitations
* $p < .05$; * * $p < .01$; * ** $p < .001$

group ($n = 1426$). Finally, the *decreasing positive* group ($n = 98$) consisted of participants who reported high parental affection but low social support and PRWO. There were 75 participants who did not meet the criteria for any of the theoretical groups, thus bringing the sample size to 6834.[1]

4.1.1. Covariates

Participants in the *high positive* group were more likely to be married at baseline, Black, and male. In contrast, participants in the *increasingly positive* group were more likely to be white and female. Participants in the *high positive* group were less likely to report alcohol abuse or be smokers (and vice versa for the *low positive* group). There were additional group differences for experienced divorce, disease burden, subjective memory, residential instability, and parental divorce/separation. Fig. 2 shows the significant differences across all four groups. See supplementary Table 1 for the specific covariate means and SDs.

4.1.2. Predicting functional limitations

We ran a multiple group analysis in Mplus, modeling the same pathways as with the data-driven groups. To compare results against the positive LPA, we used a similar baseline model: covariate regression coefficients and covariate correlations were constrained across groups, and covariate means and variances could differ across groups. Using log likelihood comparisons, results suggested that functional limitations could be constrained across all groups (see Table 7A on OSF). In other words, no group was significantly different from another group in terms of predicted functional limitations intercepts.

4.2. Positive LPA

We used step 1 of the BCH method to identify the latent profiles for the positive LPA. For clarity, we present the fit statistics and group numbers for the first 5 models tested in Table 3 (for all 9 models tested, see OSF). Using model fit criteria and interpretability, we selected the 4-profile solution. Although the entropy was higher for the 5-profile solution, the LMR Adj-LRT was no longer significant ($p = .08$). Additionally, the smallest group for the 5-profile solution consisted of 229 participants (about 3.3% of the sample), whereas the smallest group for the 4-profile solution comprised about 9% of the sample, representing a more interpretable and reliable group. A plot of the indicator variable means for each profile is shown in Fig. 3A.

Profile 1 ($n = 3786$) represents an *optimal* profile, with average parental affection and high PRWO and support. Profile 2 ($n = 629$) is characterized by the *least optimal* relationship characteristics: low affection and PRWO and very low support. Profiles 3 and 4 both reported average affection, but Profile 3 ($n = 625$; *average + low support* profile) reported average PRWO and low support, and profile 4 ($n = 1869$; *average + low PRWO* profile) reported average support but low PRWO.

4.2.1. Covariates

Participants in the *optimal* profile were more likely to be older, white, married at baseline, and female; they were less likely to be smokers. These participants reported significantly less alcohol abuse, lower disease burden, and better subjective memory. In terms of childhood environment, participants in the *optimal* profile reported significantly less residential instability and parental divorce/separation. Fig. 2 shows the significant differences for all four profiles. See supplementary Table 1 for the specific covariate means and SDs.

4.2.2. Predicting functional limitations

Step 2 of the BCH method was used to model the 4-profile LPA solution predicting later-life functional limitations. Using the optimal baseline model,[2] we used loglikelihood comparisons to determine whether constraining functional limitations across certain classes resulted in a better or worse fitting model. Results (Table 7B on OSF) suggested two groups could not be constrained: the *optimal* and *least optimal* profiles, and the *optimal* and *average + low PRWO* profiles. The predicted functional limitations intercept was significantly lower for the *optimal* profile (0.95) compared to the *least optimal* profile (1.04, $p < .001$) and the *average + low PRWO* profile (1.02, $p < .01$). Table 5 and Figure 4 on OSF show the predicted intercepts and significant comparisons.

4.3. Multivalence LPA

Step 1 of the BCH method was used to identify the latent profiles. We present the fit statistics and group numbers for the first 5 models tested in Table 4 (for all 9 models tested, see OSF). Using model fit criteria and interpretability, we selected the 4-profile solution. Although the entropy was higher and the LMR Adj-LRT was significant for the 5-profile solution, the 4-profile solution was considered optimal for two main reasons. First, the smallest group for the 5-profile solution consisted of 195 participants (about 2.8% of the sample). The smallest group for the 4-profile solution comprised roughly 10% of the sample, representing a more interpretable and reliable group. Second, the percentage change in SSA-BIC, an indicator of how much the fit is improving as number of profiles increases, was roughly the same when moving from 2 to 3 profiles and from 3 to 4 profiles but was reduced by half when moving from 4 to 5 profiles. This suggests the improvement in fit after the 4-profile solution was less substantial. A plot of the indicator variable means for each profile is shown in Fig. 3B.

The profiles for the multivalence LPA matched those from the positive LPA. Profile 1 ($n = 3551$) represents an *optimal* profile, with average parental discipline and affection, high PRWO and support, and average strain. Profile 2 ($n = 719$) is characterized by the *least optimal* relationship characteristics: average discipline, low affection, low PRWO, very low support, and high strain. Profiles 3 and 4 both reported average discipline, affection, and strain, but profile 3 ($n = 889$; *average + low support* profile) reported average PRWO but low support, and profile 4 ($n = 1750$; *average + low PRWO* profile) reported average support but low PRWO.

4.3.1. Covariates

Participants in the *optimal* profile were more likely to be older, white, married at baseline, and female. Participants in the *least optimal* and the *average + low support* profiles were more likely to be younger and less likely to be white. Moreover, participants in the *least optimal* profile reported higher levels of childhood residential instability and parental divorce/separation. Fig. 2 shows the significant differences for all four profiles. See supplementary Table 1 for the specific covariate means and SDs.

4.3.2. Predicting functional limitations

Step 2 of the BCH method was used to model the 4-profile LPA

[1] When we performed the latent profile analysis on this subsample ($n = 6834$), the results were the same as the full sample ($n = 6909$), and the 4-profile solution was considered optimal. See Table 6 in OSF for the fit statistics.

[2] The BCH default is for all covariate correlations to be constrained across classes. Given that we had no prior hypotheses about the covariate correlations, we kept the default setting and did not allow these to vary across classes. We used log likelihood comparisons to compare various model constraints to an unconditional model to determine the best fitting baseline model. Constraints involved the covariate regression coefficients, means, and variances. Log likelihood comparisons suggested that covariate regression coefficients should be constrained but all covariate means and variances could differ across profiles. Data showing the model comparisons can be found in Table 8 on OSF.

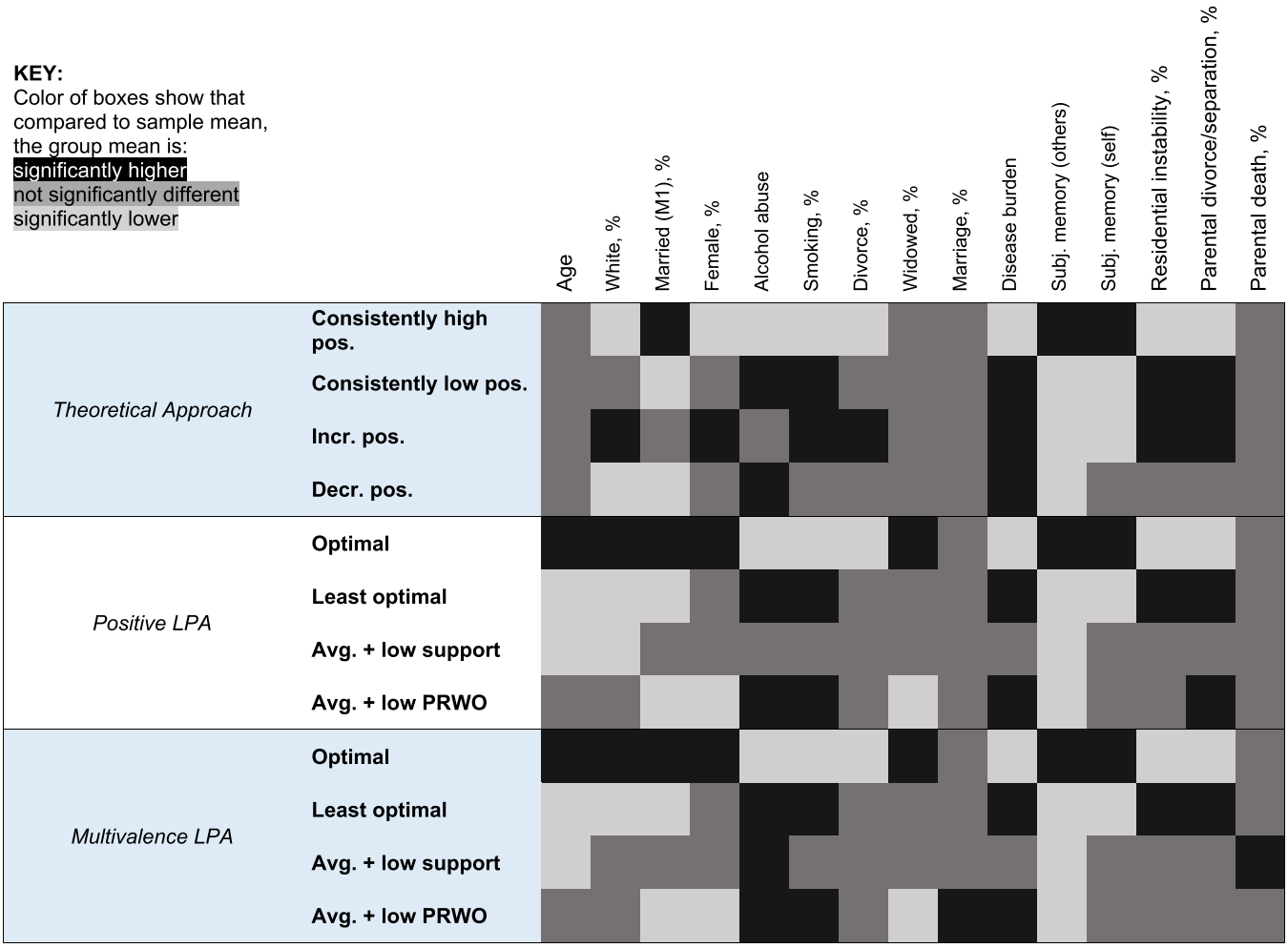

Fig. 2. Heat map of covariates across groups for each approach.

Table 3
Summary of model for fit for positive latent profile models (n = 6909).

# classes	AIC	BIC	SSA-BIC	Entropy	p-value for LMR Adj- LRT	Groups
1	46468.702	46509.746	46490.679	-	-	-
2	43525.849	43594.255	43562.477	0.76	< .001	1–2328 2–4581
3	42659.095	42754.863	42710.375	0.76	< .001	1–637 2–2029 3–4243
4	**42122.691**	**42245.822**	**42188.622**	**0.76**	**< .001**	**1–3786** **2–629** **3–625** **4–1869**
5	41611.888	41762.381	41692.47	0.85	0.08	1–229 2–392 3–2092 4–3176 5–1020

Note. The chosen model is displayed in bold. AIC = Akaike information criteria; BIC = Bayesian information criteria; SSA-BIC = sample-size adjusted BIC; LMR Adj-LRT = Lo-Mendell-Rubin adjusted likelihood ratio test.

solution predicting later-life functional limitations. For the sake of comparison, we adopted the same baseline model (i.e., covariate regression coefficients constrained across classes, covariate means and variances could differ). As the default, covariate correlations were constrained across classes.

Log likelihood comparisons (Table 7C on OSF) suggested three contrasts could not be constrained: the *optimal* and *least optimal* profiles, the *optimal* and *average + low PRWO* profiles, and the *optimal* and *average + low support* profiles. The predicted functional limitations intercept was significantly lower for the *optimal* profile (0.94) compared to the *least optimal* (1.03, $p < .001$), the *average + low PRWO* (1.03, $p < .001$), and the *average + low support* (1.00, $p = .045$) profiles. Table 5 and Figure 4 on OSF show the predicted intercepts and the comparisons that were significant.

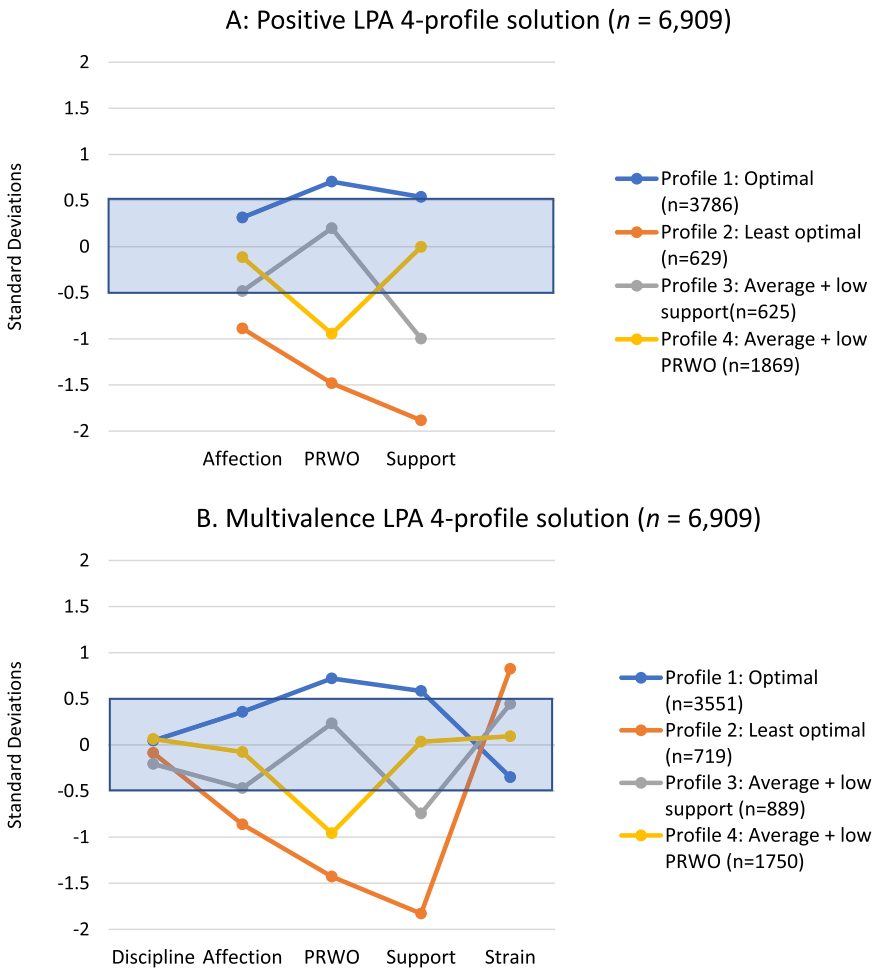

Fig. 3. 3A: Positive LPA 4-profile solution (n = 6909). 3B. Multivalence LPA 4-profile solution (n = 6909). *Note:* PRWO = positive relations with others. The shaded box in the middle represents average scores between − 0.5 and 0.5 SDs from the mean; values outside of this range indicate what we consider high/low.

Table 4
Summary of model fit for multivalent latent profile models (n = 6909).

# classes	AIC	BIC	SSA-BIC	Entropy	p-value for LMR Adj- LRT	Groups: *n*
1	68144.462	68212.868	68181.09	-	-	-
2	64441.959	64551.409	64500.564	0.75	< .001	1–5207 2–1702
3	63571.57	63722.062	63652.152	0.72	< .001	1–558 2–2409 3–3942
4	**62860.269**	**63051.806**	**62962.828**	**0.74**	**< .001**	**1–3551** **2–719** **3–889** **4–1750**
5	62519.05	62751.63	62643.586	0.76	0.01	1–808 2–1552 3–3340 4–195 5–1014

Note. The chosen model is displayed in bold. AIC = Akaike information criteria; BIC = Bayesian information criteria; SSA-BIC = sample-size adjusted BIC; LMR Adj-LRT = Lo-Mendell-Rubin adjusted likelihood ratio test.

4.4. Aim 1: comparison of positive theoretical approach to positive LPA

For parsimony, we compare the *optimal* profile from the positive LPA to the *high positive* group from the theoretical approach, and the *least optimal* profile to the *low positive* group. However, the remaining two profiles from the LPA do not conceptually map on to the two remaining groups from the theoretical approach.

Supplementary Table 2 shows a cross tab of participant distribution across approaches. Compared to the *optimal* profile (n = 3786) from the positive LPA, considerably more participants were placed in the *high positive* (n = 5162) theoretical group. Notably, the *high positive* group was over 35% larger than the optimal profile. Participants in the *high positive* group primarily came from the *optimal* profile and the *average + low PRWO* profile. The *low positive* and *decreasing positive* groups were

Table 5
Predicted functional limitations intercepts.

		FL intercept	
		Model 1	*Post-Hoc*
Multivalence LPA	*Optimal*	0.939883[a, b, c]	0.721805[a, b, c]
	Least optimal	1.033551	0.890475
	Avg. + low support	1.003005	0.80493[a]
	Avg. + low PRWO	1.032518	0.829444[a]
Positive LPA	*Optimal*	0.953134[a, c]	0.733447[a, b, c]
	Least optimal	1.042894	0.903933
	Avg. + low support	1.016129	0.815462
	Avg. + low PRWO	1.02429	0.824482[a]
Theoretical Approach	*High positive*	1.020201	0.800115
	Low positive	1.018163	0.871099[d]
	Incr. positive	1.026341	0.832768[d]
	Decr. positive	1.006018	0.872843

Note. FL = functional limitations. All pairwise comparisons were made within each approach. Model 1 = all covariates included; Post-hoc = potential pathway covariates (smoking, alcohol dependence, disease burden, subjective memory, adult marital transitions) removed. Superscripts represent significant differences with indicated group at the $p < .05$ level: [a]least optimal; [b]avg. + low support; [c]avg. + low PRWO; [d]high positive

both small; members of these two groups belonged to only the *least optimal* profile from the positive LPA. The *increasing positive* group comprised participants from all four LPA profiles, primarily the *average + low PRWO* and *optimal* profiles.

Similar to the *optimal* profile from the positive LPA, the *high positive* theoretical group was more likely to be married. However, although the *optimal* profile was more likely to be older, white and female, the *high positive* group was less likely to be white and more likely to be male (and showed no significant difference for age). The means for the health behaviors and health outcomes, although slightly varied across approaches, were consistent in that the *optimal* profile and *high positive* group reported the "better" means (e.g., less alcohol abuse, better subjective memory) and the *least optimal* profile and *low positive* group reported the "worse" means (e.g., more alcohol abuse, worse subjective memory). See Supplementary Table 1.

The theoretical approach did not identify any significant differences in predicted functional limitations intercepts across groups. Compared to the positive LPA, there was less variation in functional limitations across the theoretical groups (range: 1.01 – 1.03; see Table 5). Specifically, the *high positive* group had a higher predicted functional limitations intercept than the *optimal* profile in the positive LPA, thus hindering the likelihood of identifying significant differences among the groups, particularly since the significant differences for the positive LPA were between the *optimal* profile and one of the other profiles.

4.5. Aim 2: comparison of positive LPA to multivalence LPA

Although the multivalence and positive LPAs both resulted in 4-profile solutions, the composition of those profiles did vary. Supplementary Table 3 shows a cross tab of participant distribution across LPA approaches. The largest shift ($n = 225$) occurred for participants who were assigned to the *optimal* profile for the positive LPA but moved to the *average + low support* profile when parental discipline and social strain measures were added for the multivalence LPA. Comparing scores for those who stayed in the same profile across the two LPAs to those who switched to a different profile when discipline and strain were added, a few findings emerged (see pp. 27–28 of the Technical Report on OSF). First, scores on discipline were not meaningfully different for participants who switched profiles compared to those who did not switch. Second, participants who switched profiles reported strain scores that differed from those who did not switch, suggesting some within-group differences in strain. Finally, adding discipline and strain in the multivalence LPA helped tease apart more nuanced differences in some of the positive relationship dimensions. For example, participants who were in the *average + low PRWO* profile for both LPAs reported lower PRWO than those who switched from the *average + low PRWO* profile to the *optimal* or the *average + low support* profiles in the multivalence LPA.

The covariates mapped onto the positive LPA profiles in similar ways as the multivalence LPA profiles (see Fig. 2). For example, although the covariate means slightly differed for some variables, the *optimal* profile was more likely to be older, white, married at baseline, and female for both approaches. Moreover, although the two LPA approaches show some differences in terms of which covariates are significantly different from the sample mean, the actual covariate values are the same or very similar (Supplementary Table 1).

The multivalence LPA suggested one additional, though trivial, significant difference (the *optimal* profile vs. the *average + low support* profile) compared to the positive LPA. The predicted functional limitations intercept for the *average + low support* profile was similar across LPAs (1.00 for the multivalence LPA, 1.02 for the positive LPA). Moreover, the p-values for this specific contrast were similar across LPAs (.045 for the multivalence, .056 for the positive; Tables 7B and 7C on OSF) but only one reached significance. Although the multivalence LPA detected one more significant difference than the positive LPA, the LPAs do not appear to meaningfully differ in predicted functional limitations.

4.6. Post-hoc analysis

It is possible that some of the covariates of interest are on the causal pathway between social relationships and functional limitations (i.e., are mediators; see Limitations). To account for this possibility, we compared the approaches with only the demographic and childhood environment covariates (i.e., age, sex, race, marital status at baseline, residential instability, parental divorce/separation, and parental death). In this post-hoc analysis, the predicted functional limitations intercepts and resulting group comparisons differed (see Table 5). Overall, all predicted functional limitations intercepts were lower when fewer covariates were included. Compared to the model with all covariates, two additional significant group differences emerged for each of the three approaches when we removed the potential pathway covariates (i.e., smoking, alcohol dependence, disease burden, subjective memory, and adult marital transitions).

5. Discussion

Past research has highlighted the significant, albeit complex, association between relationships and health across the life course. The present study advanced this work by examining three analytic approaches that account for life course trajectories of social relationships and their associations with later-life functional limitations. Our findings suggested that the data-driven approach was a stronger predictor of functional limitations than the theoretical approach. Moreover, comparing the two LPA approaches, the positive relationship indicators performed equally well as the multivalent relationship indicators.

5.1. Theory vs. positive LPA

Our first aim compared the a priori theoretical approach to the positive LPA approach. Overall, the theoretical approach revealed different patterns of association compared to the data-driven approach. Specifically, some demographic covariates substantially varied across approaches; most notably, the *consistently high positive* group in the theoretical approach was less likely to be white and female, whereas the *optimal* LPA profile was more likely to be white and female. Despite some demographic differences, the theoretical groups were similar to the LPA profiles on several health measures. For example, both the *high positive* group and *optimal* profile reported significantly less alcohol abuse and smoking; less disease burden; and better subjective memory. Finally, compared to the data-driven approach, the theoretical approach was less sensitive in detecting significant differences in functional limitations.

These results suggest that the data-driven approach was more discriminating than the theoretical solution. Moreover, the group assignment across approaches varied considerably. As noted in the results, the criteria used for the theoretical approach resulted in a *high positive* group that was over 35% larger than the *optimal* profile from the positive LPA. A majority of the participants in the *average + low PRWO* profile from the LPA were placed into the *high positive* group for the theoretical approach. Thus, one possible explanation for why the theoretical approach was less discriminating overall is that there is something inherently different about participants in the *average + low PRWO* profile. Based on the criteria used in the theoretical approach, participants could be placed into the *high positive* group if they reported high levels of parental affection and high levels of social support, regardless of their scores on PRWO. One interpretation of our findings is that the PRWO relationship measure is tapping into something unique and influential, potentially driving differences in functional limitations and some of the covariates. Because PRWO is a measure of relationship quality, this highlights the importance of considering relationship quality (outside of the marital domain) to understand associations between social relationships and health.

5.2. Valence of relationships

With our second aim, we sought to compare LPA approaches that included differently valanced relationship information. Overall, the LPA approaches were very similar to each other in terms of covariates and ability to predict later-life functional limitations.

Prior research suggests that including multivalent relationship information can often be more informative than including only positive or only negative aspects of relationships (e.g., Rook, 2015). In the present study, the multivalence LPA included the same measures as the positive LPA with the addition of parental discipline and social strain. Although social strain did yield some differences in profile characterizations, results suggested that the parental discipline measure did not contribute much to the distribution of the profiles. There are several reasons why this may have been the case.

Some research suggests only fair agreement between adolescents' self-reports and their adult retrospective reports of parental discipline practices (Offer et al., 2000; White et al., 2007), and recall of negative childhood experiences may be particularly susceptible to memory inaccuracy (Raphael et al., 2001). Moreover, parental characteristics, child temperament, and social context may all contribute to the type and frequency of discipline used (Wade & Kendler, 2001), as well as the consequence of the discipline. Perhaps most importantly, the retrospective measure of parental discipline in the present study was likely too non-specific to be informative. Although there is extensive research documenting the effects of specific types of discipline (e.g., harsh discipline; Mackenbach et al., 2014), the discipline items used in this study were more general and did not tap into an unambiguous, well-studied type of discipline. In other words, the discipline measure may not have been contextualized enough to be useful.

6. Application of theory

Much of the existing research on social connectedness and health is limited in its narrow conceptualization of social relationships. For example, most of the literature on social relationships and functional limitations focuses on one stage of the life course (often exclusively on older adulthood; e.g., Ryan et al., 2014; Thomas, 2011). Research has consistently shown that social connectedness in adulthood is inversely related to functional limitations and protects against functional decline (e.g., Choi et al., 2016; Lachman & Agrigoroaei, 2010; Thomas, 2011). The present study extends this work by including social relationships in childhood *and* adulthood to examine how life course relationship typologies predict functional limitations.

Although the LPA performed better than the theoretical approach in predicting functional limitations, the patterns identified by the LPA highlight important theoretical processes. Specifically, the *optimal* and *least optimal* profiles underscore the influence of potential cumulative processes. Participants who reported cumulatively positive relationships (i.e., *optimal* profile) fared better in terms of functional health and other health covariates compared to those who reported cumulatively poor relationships (i.e., *least optimal* profile) as well as those who reported mostly average relationships (i.e., *average + low PRWO* profile).

The results from the LPA did not, however, evoke all of the processes from the life course timing principle. Based on the timing principle and observed heterogeneity in aging, we would theoretically expect that it would be plausible for people who are less advantaged in early life to still have positive health and social outcomes in later life (and vice versa). The LPA did not suggest a profile that fit these characteristics. Rather, in addition to the *optimal* profile (cumulatively good) and *least optimal* profile (cumulatively bad), the remaining two profiles reported average social relationships across the life course aside from differences in social support and PRWO in adulthood. These findings could be a function of the relationship measures used, and more comprehensive measures of relationships in childhood might suggest different trajectories more consistent with the timing principle.

7. Limitations, strengths, and conclusions

Some limitations should be considered. Although parent-child relationships are arguably the most important for young children and have life-long health effects (Chen et al., 2011; Luecken et al., 2013), other early relationships (e.g., those with peers or siblings) that might also influence adult health are not included in MIDUS and so could not be evaluated.

As noted above, self-reported, retrospective measures of childhood relationships may be subject to measurement error due to imperfect memory or response bias. Additionally, the parental discipline measure was included in the multivalence LPA to attempt to balance the parental affection measure and provide a more complete picture of the parent-child relationship. However, in this study the parental discipline measure did not meaningfully contribute to our understanding of relationship typologies. One potential explanation could be that there was very limited variability in the discipline measure. Moreover, consistent with the conceptual ambiguity related to the parental discipline measure, it could be that this measure of discipline is not a negative relationship characteristic. Future research may want to consider other measures of parent-child relationships that could better capture the negative or strained aspects of the relationship. For example, less ambiguous negative measures, such as harsh discipline, could be more informative. The MIDUS dataset does include measures of physical abuse and emotional neglect experienced during childhood (elements of the Childhood Trauma Questionnaire), but these are only included in the biomarker subsample ($n = 1255$).

As noted in the post-hoc analysis, some of the covariates we included may function as mediators in the association between life-course social connectedness and later-life functional limitations. The results changed when these covariates were removed, which suggests that this may be a possibility worth exploring in future work but is beyond the scope of the present study.

Finally, functional limitations were measured using a self-reported assessment, which is not always the most reliable. That said, self-reports of functional limitations do seem to be slightly positively biased but reasonably accurate and reliable (Bravell et al., 2011; Brazier et al., 1992). The current results could be bolstered by analyses involving objective assessments of functional capacity.

Despite the limitations, this study also has several strengths. MIDUS is a large, demographically diverse national sample with assessments spanning multiple decades that permit the examination of different life course stages and a longer period than other aging studies. The rich data included in MIDUS also allowed for the inclusion of multiple social

relationship variables and several important covariates. Additionally, a significant strength of this study is the use of the life course framework to better understand different types of relationships across multiple stages of the life course and their association with later-life functional limitations.

Moreover, including both positive and negative relationship characteristics in the multivalence LPA allowed us to consider positive and negative aspects of social ties together, a current priority in relationship research (Rook, 2015). In the present study, results were very similar across LPA approaches, although the multivalence LPA was slightly more discriminating in terms of profile assignment and predicting functional limitations. This suggests that in this particular dataset, the positive relationship measures were fundamentally equally as informative as both the positive and negative relationship measures together.

Interestingly, in both the multivalence and positive LPAs, the *optimal* profile was characterized as the oldest and most healthy (e.g., fewest functional limitations). This could be partly due to survivor bias; in other words, the participants who make it to older age and continue participating in the study may be generally healthier than those who do not. Although not a primary interest of this study, it would be interesting to examine these analytic approaches in primarily younger or primarily older samples, particularly since relationships may have differing influences depending on when they occur in the life course (Elder, 1998). Given the large age range of MIDUS, our conceptualization of adult social connectedness (measured at Wave 1) could have different meaning based on participants' age. For example, the social connectedness measures may tap into something different for a 25-year-old than a 75-year-old, but both participants' data would be included at Wave 1. Similarly, the association between social connectedness and functional limitations over a 20-year period may differ based on participants' starting age.

The results of this study provide important insights into how future researchers should apply theory to understanding relationship trajectories across the life course. As demonstrated in this study, the theoretical foundations (i.e., life course perspective and cumulative [dis] advantage) are currently not specific enough to determine which groups, or patterns of relationship characteristics, are likely to be most populated and important. Knowing which constellations are likely to be most important could help narrow the groups (i.e., using four relationship indicators wouldn't necessarily result in 16 groups) and more accurately classify people into certain groups. In order to improve the theoretical specification of life course relationship trajectories, future work should be done to better redefine theory to inform the a priori groupings. Greater theoretical specificity could also provide insight into how early relationships should be measured and defined. Overall, the data driven approaches in this study provided robust support for cumulative processes (less so for the timing and life course development principles). Improving theoretical specifications could help advance these findings. When researchers can accurately implement both data-driven and theoretical approaches, they can corroborate the findings more so than using only one approach or the other, thus increasing our confidence in the results.

Researchers should carefully consider the pros and cons of the particular approach they choose to examine relationships across the life course. In a large, national sample, this study demonstrated that the data-driven profiles had more predictive power than theory-based groups, which is theoretically and methodologically meaningful for understanding associations between life-course relationships and health.

Declaration of interest

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.alcr.2023.100529.

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