

## Advances in Life Course Research

### Commentary

#### From the life-course cube to an open state-space system

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Studies of the human life course have flourished since the 1970s, inspired by the research paradigms formulated by Glen Elder in his seminal work on Children of the Great Depression (Elder, 1999). Focusing on the crucial role of social forces shaping the life course and its developmental consequences, he identified the importance of historical time and social change, the timing of lives (emphasising the social meaning of age or social timing), social relationships (linked lives), and human agency relating individuals to the broader social context through planful choices made within the constraints of their world.

The life course is understood as the interweave of age-graded trajectories, linking education and work careers as well as family pathways, all of which are subject to changing conditions and anticipated future options, extending from short-term transitions in early life to retirement and old age. Spurred by increasing availability of high quality longitudinal data and methodological advances (see Piccarretta & Studer; Brüderl, Kratz & Bauer; Mund & Nestler; and Hollstein (all this issue), life course thinking has infused research across disciplinary boundaries, with applications in sociology, social demography, family studies, social stratification theories, developmental science, historical science, criminology and social epidemiology (Mayer, 2009; Settersten & Mayer, 1997). Moreover, the rapid growth of longitudinal studies that link childhood experiences to the adaptations of later life has facilitated what might be called a “whole life course” approach to human development and aging (Elder, Shanahan, & Jennings, 2015), an understanding that the trajectory of human development and aging begins in the prenatal period.

Robust empirical evidence has been gathered regarding age-related changes in functioning across domains (i.e., educational attainment, social mobility, health, wellbeing and aging), exploring how biological, psychological, and social risk trajectories, acting across the whole life course, influence age-related patterns of adjustment, functional decline, disease and disability. For example, evidence in the fields of criminology (Sampson & Laub, 2005), epidemiology (Blane, Netuveli, & Stone, 2007; Kuh, 2016), epigenetics (Shanahan & Hofer, 2005), developmental science (Schoon, 2006; Silbereisen & Pinquart, 2008), and social research (Diewald, 2016; Mortimer, 2008) has highlighted a range of general principles about how individuals are influenced by, react to, and shape a changing social context throughout their life course. These

include processes of social causation, selection, accumulation, path dependencies, spill-over effects, resource compensation, bounded agency, co-agency, and turning points.

Aiming to formulate a systematic approach that integrates key concepts and mechanisms linking individuals and context over time and that is applicable across disciplines, Bernadi, Huinink & Settersten (this issue) have conceptualised a tool for studying lives in the shape of a life course cube. The life course cube reduces the complexity of multiple interlinked levels of influence to 3 dimensions: time (past, present, future), levels (intra-individual, individual, and supra-individual), and life domains (e.g., education, work, family, leisure). The life domains can vary and potentially be expanded to include different or emerging themes, such as health, wellbeing, living conditions, or social media. The approach succeeds in systematising our thinking regarding the multiple interlinked dimensions that shape individual behaviour, and enables researchers to locate their study within an integrative life course framework.

Moreover, the life course cube specifies the interdependencies between the different dimensions in terms of first-, second-, and third-order interdependencies. First-order interdependencies relate to each of the 3 dimensions: time, domain and context. Regarding time-related interdependencies, processes of path dependencies, anticipation and turning points are highlighted. Regarding life domains, the issue of resources is central, comprising processes of resource competition, compensation, spill-over effects, substitution effects, marginal utility and investments in different domains. Regarding levels, interlinkages refer to micro-, meso-, and macro-level processes, including the social patterning of lives (in particular regarding supra-individual forces) and (inner) individual regulation.

Any of these first-order interdependencies can themselves interact, creating the second- and third-order interdependencies, i.e. ‘infusing time into each of the levels and domains’ and creating a better understanding of interactions between supra-individual structures, such as welfare systems, individual and intra-individual experiences and the different domains. These second- and third-level interactions comprise for example normative life scripts and social expectations regarding the timing and sequencing of individual trajectories, socialisation effects, processes of selection and causation, developmental regulation and control, co-evolution, biological programming and maturation processes, and even the embodiment of social structures at the inner-individual level through developmental processes of habituation, learning, damage and repair (Kuh, 2016).

In conceptualising these interdependencies, Bernadi, Huinink & Settersten (this issue) point out that the different subsystems do follow different, and even incompatible goals and time tables. In an appendix they offer a very helpful formal representation of the life course as a stochastic process, specifying development and interdependencies over time, across levels and domains.

The simplicity and logic of the approach offer indeed a major advancement towards an integrated life course theory. In particular the specification of key dimensions and their stochastic formalisation enables researchers from different disciplines to specify their research questions and hypotheses and to locate their approach within a comprehensive multi-level and multi-dimensional framework. The authors have thus succeeded in achieving their aim of providing a systematized approach to life course theory, integrating assumptions regarding key concepts and multi-dimensional interlinkages derived from different disciplines.

The usefulness of the approach is illustrated in the paper by Bidart (this issue), who applies the life course cube to examine how individuals anticipate their futures and what happens when their plans are disrupted by unforeseen events or changing circumstances. Drawing on evidence from a qualitative longitudinal survey, following the lives of young people in their transition to independent adulthood over a 20 year period, she shows that changes in interdependencies of levels and domains over time are indeed the source of the unpredictabilities that can redirect development and associated behaviours. Expectations regarding future outcomes are constantly adjusted in response to confrontations with changing realities and unforeseen events. Of particular importance in this study are changing family circumstances in terms of committed romantic relationships and associated changes in values and desires, as well as obligations to the family of origin and destination, highlighting the importance of ‘linked lives’ as defined in Elder’s (1974) life course paradigm. Moreover, Bidart (this issue) emphasises that studying changes in direction over the life course may be at least as fruitful as studies focusing on the realisation of anticipated goals, enabling a better understanding of anticipation as a provisional vision of the future, situated at the junction of a plurality of shifting contexts and circumstances, thus expanding the conceptualisation of agency.

The contribution by Heckhausen and Buchmann (this issue) introduces the concepts of developmental canalization (reflecting inter-individual processes) and societal canalization (reflecting supra-individual processes), advancing the understanding of first-level interdependencies between levels. Drawing on motivational theories developed within life-span and social structure based life-course sociology they formulate a set of propositions regarding optimal (adaptive) and suboptimal (maladaptive) timing of agency in the life course and the effect of age-grading and social structure in shaping the motivation and developmental self-regulation required to pursue major life goals across domains. They focus in particular on processes of selective optimisation and compensation that involve goal selection, goal engagement, goal disengagement, action crisis and adjustment.

Asking under what conditions can agency be most effective, they provide a set of scenarios that illustrate processes of self-socialisation and their interlinkage with social-structure based path dependency. In particular, they describe compensatory or amplification effects across life course domains and over time. For example, the experience of early advantage, such as high levels of

educational attainment or academic self-concept, is likely to persist, grow larger or spill-over to other domains for individuals from relative advantaged families, whereas it is likely to attenuate for those from less privileged families. The experience of cumulative advantage makes it easier for individuals from a privileged background to take a risk, or make ambitious plans regarding their education and career goals, because they have more resources to fall back onto if things do not go as planned. In turn, individuals with ambitious goals from a less privileged background can withstand and overcome set-backs if they can look back on a range of personal experiences in which they successfully mastered educational or work-related challenges. Such compensatory agency can however be associated with high costs in terms of less investment in other domains of life, such as family or leisure.

Thus, according to Heckhausen & Buchmann (this issue) individuals from less privileged family background are more likely to play it safe, i.e. to set themselves less ambitious goals, creating an amplified spiral of social disadvantage. Although it is in principle possible to redirect the life course and to overcome societal constraints, potential compensatory processes require higher levels of agentic commitment, might bring with it extra costs, and are facilitated under conditions of transparent and expected constraints.

The papers by Bidart and by Heckhausen and Buchmann (this issue) both advance our understanding of the life course cube and provide helpful illustrations, in particular regarding third-order interdependencies of the different life course dimensions. Indeed, to comprehensibly conceptualise the dynamic interactions between a developing individual in a changing social context, such third-order interdependencies are vital. Specifying the different dimensions and levels of influence shaping life course development, as illustrated in the life course cube (Bernadi, Huinink & Settersten, this issue), is indeed an important step towards a more systematic conceptualisation of life course structures and processes. But is the proposed systematized theory of human action sufficient as a framework and theoretical foundation to guide the development of life course research and its integration across disciplines?

The life course cube conceptualises human development as a self-referential process which is characteristic of action research, integrating a meta-structural analysis with a voluntary theory. Less attention is given to the historical context, the role of place, or reciprocal interactions and exchange with other systems. For example, there no consideration of inter-individual processes, shared meaning, or processes of co-agency that might generate new structures or changing realities. Specifically, the life course cube does not specify processes of ‘linked lives,’ as emphasised by Elder (1974) and also Bidart (this issue). As Mayer (this issue) suggests, the notion of ‘linked lives’ may be represented in the form of ‘linked life course cubes.’ An alternative option would be to understand the life course not within an action theoretical approach, but within an open systems approach, i.e. as a process of becoming based on reciprocal exchange between systems (Bertalanffy, 1969). Instead of a cube, the life course could

be represented as an open state-space vector model (Katzfuss, Stroud, & Wikle, 2016), which is used across disciplines to represent the dynamic interactions between a set of input, output and state variables. Non-linear, dynamic state-space models are used, for example, in economics to forecast stock prices (Stroud, Muller, & Sanso, 2001), in neuro sciences to predict task accuracy (Molenaar, Beltz, Gates, & Wilson, 2016), or zoology (Taylor, Reynolds, & Thomas, 2016) to predict the flight path of birds. The state-space representation provides a convenient and compact way to model and analyze systems with multiple inputs and outputs and shifting-base updates, even for high-dimensional state spaces. A state-space model would enable the inclusion of additional dimensions, such as historical time and place, linked lives, linked systems, shared culture, and even random chance events.

Offering an attempt of systematizing key concepts and mechanisms linking individuals and contexts over time, Bernardi, Huinink & Settersten (this issue) have made an important step towards an integrative theoretical framework for studying lives over time and in context. Their approach forces the reflection on vital axes of interdependencies and their conceptualisation, but also on the potential of an open systems approach as an alternative to action theory in conceptualising how the life course unfolds.

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