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Title: Beyond the family life-cycle: Understanding family development in the 21st century through complexity theories.

Ana Teixeira de Melo Faculty of Psychology and Education Sciences of the University of Coimbra, Portugal.

Madalena Alarcão, Faculty of Psychology and Education Sciences of the University of Coimbra, Portugal.

Corresponding contacts:

Ana Teixeira de Melo, Apartado 1562, EC Devesas, 4400-Vila Nova de Gaia, Portugal;

E-mail: anamelopsi@gmail.com;

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Abstract

Perspectives on family development have been organized, mainly, around the idea of the family life cycle. However, a family life-cycle approach is probably too simplistic and norm-oriented to understand family development, particularly in face of the diversity of family forms and challenges in the 21st century. In this paper, we discuss how family science can borrow inspiration from concepts and methods of complexity sciences in order to (re)conceptualize family development as the time unfolding of a complex self-organizing system, in the direction of increasing differentiation and integration. We highlight some strategies to inspect developmental coordination dynamics at the level of the whole family, as a complex system. We hope this reflection opens a new space of debate and new avenues for theoretical development and research in the field of family science.

Keywords: family development; complexity; coordination dynamics; family theory; developmental dynamics; family life-cycle

Beyond the family life cycle: Understanding family development in the 21st century through complexity theories

Family development is commonly conceptualized from a life cycle perspective (Carter & McGoldrick, 1989; Relvas, 1996). While useful to understand relevant family tasks and the core challenges related to the internal transformations of the family, a life cycle approach is, still, a somehow restricted perspective. It seems insufficient to grasp the diversity of family forms and the complexity of the family's life circumstances of our times. It has also been criticized for not reflecting the relational family processes unfolding from earlier constructions (Wynne, 1984). These theories lack a coherent process-focused model of what emerges and is renegotiated, through time, both continuously and discontinuously, as a function of the family members' interactions (Fogel, 1993). We are left with the feeling that something is missing in our models to capture the coherent, organized, patterned and continuous nature of human development along with the qualitative transformations associated with the emergence of novelty, through time (Lerner, 2002; Thelen, 2005; van Geert, 2000, 2003). Additionally, there is the question of knowing what develops and how development occurs, in families, as integrated systemic entities.

Structural (Minuchin, 1974) and family stress models (Lavee, McCubbin, & Patterson, 1985; McCubbin & Figley, 1983; Patterson, 2002) provide some clues on the mechanisms underlying family adaptation. They attend to the effect of time in the balance between the family's resources, its meaning making activities and the piling up of stressors (Lavee et al., 1985). Somehow, as all systemic approaches (Cox & Paley, 1997), these models assume that there are collective variables that make a difference above the sum of individual ones.

Family resilience models also incorporate these insights proposing that collective variables such as those describing the family' belief system, its organizational, communication and problem-solving patterns play an essential role in the family's adaptation (Walsh, 2006).

Nevertheless, these perspectives tells us little about how these dimensions first appear, how they relate to each other and how they change during the family life trajectory. Families, as systems, appear to be integrated collections of patterns, processes, functions and structures, emerging spontaneously from the recurrent interaction of its members, and their own components, and operating, thereafter, according to its own intrinsic rules and dynamics (Kelso & EngstrØm, 2006). They show properties of complex non-equilibrium, self-organizing dynamic systems (Haken, 2008).

Many developmentalists subscribe an organismic, probabilistic and contextual view of development framed by a systems perspective (Lerner, 2002). Within a dynamical systems perspective, human development is a process of successive and systematic transformations of each individual organization over time (Lerner, 2002). Development may be understood as the pathway of recursive activities of an organism and the transformations resulting from the recurrent interactions and the structural coupling with its milieu (Maturana & Varela, 1992). Development is also a trajectory of changes of progressive differentiation and integration (Lerner, 2002; Thelen, 2005). However, when concerning family development, the application of these ideas is underexplored.

As family science became well established, family research showed increasing specialization. Most research studies targeting the family focus very particular dimensions and specific variables of family functioning. On the other hand, many

family studies focus either a particular sub-system (e.g. marital, parent-child) or a specific type of interaction, most commonly dyadic, and not the entire family system (Cox & Paley, 1997, 2003). Additionally, most studies attend to family dimensions in relation to individual adaptation and developmental outcomes and not so much to the developmental outcomes at the whole-family level. Successful developmental outcomes at the family level can be hard to operacionalize. Nevertheless, Patterson (2002) proposed, in respect to family resilience, that they be considered in terms of the successful fulfillment of family core functions.

We seem to be able to define the family as a system. However, do we truly understand what unfolds during family development and what is transformed or preserved through time? Do we know what processes underlie these transformations and how they relate to positive developmental outcomes at the family level? Moreover, what implications come out of this? We believe the literature has not provided thorough answers to these questions.

Although a systemic conception of the family is widespread, the specific properties of that system to which we call a family may not be fully understood. In face of the diversity of family forms and functions, the definition of a family in the 21st century should not depend of family members coming in and out of the family, on biological ties, the gender of the adults, or the presence of a child. The family has been conveniently and, we believe, properly, defined as a system but maybe family science can inspect in more depth the implications of such definition in order to understand what humans experience as part of a family. We believe it is time to renew our answers to the questions of what constitutes a family, what kind of a system the family constitutes, what develops in it and how it develops. Answers to these questions may bring the field closer to finding more effective support strategies for families struggling

to conserve their organization (Maturana & Varela, 1992) in face of the most complex challenges of our time.

We stand for the need to take a new look into the family as a whole relational unit and to explore its properties in depth borrowing inspiration from the most recent advances in systems thinking, namely from the interdisciplinary science of complex systems, to which we will refer to, hereafter, as Complexity Science or, simply, Complexity.

Complexity Science

Complexity Science emerged from the continuous development of systems theories and the integration of knowledge produced in such diverse disciplines as physics, chemistry and biology, in a shared recognition of the complexity and nonlinearity of our world (Érdi, 2008; Mitchell, 2009). It stimulated a profound transformation in the prevailing conceptions about the physical, the biological and social worlds (Prigogine & Stengers, 1984). Complexity focuses complex systems aiming to understand how different individual elements, interacting by, often, simple rules, and without external control, spontaneously give rise to the complex organizational patterns, structures and functions which characterize the different levels of organization of our world (Haken, 1981, 2008). These complex patterns emerge from the nonlinear interactions of simple elements (Prigogine & Stengers, 1984), in the frontier between chaos and rigidity, order and disorder (Nicolis & Rouvas-Nicolis, 2007; Prigogine & Stengers, 1984; Sporn, 2007). Complex systems maintain a dynamic stability, being prone to small fluctuations (Kelso, 1995) which prepare it to change when the conditions are critical. They are adaptive and develop in close relation to their milieus, although the higher levels (patterns) experience change at a slower pace than the lower level (individual components), where turbulence is the rule (Kelso, 1995;

Prigogine & Stengers, 1984). Through mysterious mechanisms of self-organization (Haken, 1981; Mitchell, 2009; Prigogine & Stengers, 1984) these systems are patterned and differentiated into distinct levels of organization which are subsequently integrated in a coherent whole. Different timescales apply to each level (Kelso, 1995; Thelen, Ulrich, & Wolff, 1991) and the emergent higher-level patterns constrain the behavior of the lower-level elements (Haken, 1981).

Collective variables or order parameters describe and explain the different states of the system (Haken, 1981; Kelso, 1995). They correspond to a compression of information, through a reduction of degrees of freedom. It is through coupling that the elements of a system give rise to coherent organized patterns. Once formed, these collective patterns enslave (Haken, 1981) the elements that give rise to it, imposing its rules on them. Therefore, both bottom-up and top-down processes are part of the reciprocal causality sustaining complex systems (Thompson & Varela, 2001). The emergent structures or functions grant the system some stability in face of perturbations from the milieu but are also disturbed by them or its own internal conditions. Near critical points, determined by specific control parameters (Haken, 1981; Kelso, 1995), the fluctuations increase until reaching a bifurcation, a point where the system changes into a new arrangement or a different state. It may also alternate between states, periodically or quasi-periodically (Milnor, 2006), or assume only tendencies (Kelso, 2012). This happens in all living systems since the exchange of matter, energy and information with their environment, and each other, creates inhomogeneity which drives the system away from equilibrium and forces the emergence of dissipative coordinated structures to stabilize the system by dissipating the gradients created, which act as control parameters (Tschacher & Haken, 2007). There are periods of relative stability (equilibrium) and change (non-equilibrium) (Kelso, 1995; Prigogine & Stengers, 1984).

These systems show nonlinear and unpredictable behavior, particularly when far from equilibrium, and their properties cannot be explained by the summation of those of its components.

Complex systems are dynamic or time dependent. Dynamical systems are the mathematical representation of the evolution of a system in a state or phase space, the space where all the available states or dimensions needed to characterize a system are represented (Meiss, 2007).

Dynamical Systems Theory is an important part of Complexity providing the adequate tools for the exploration of the system's behavior through time and its qualitative changes. One of the reasons why it was adopted by many developmentalists is that it gives researchers the resources to track time-dependent processes and emergent phenomena.

Dynamical Systems Theory (DST) in developmental science is represented by the work of authors such as Fogel (1993) Lewis (2000), Thelen and Smith (Thelen, 2005; Thelen, et al., 1991) and van Geert (2000, 2003), to name some of the leading figures. The contribution of their approaches has been significant, to a more encompassing and rich view of the processes involved in development (Hollenstein, 2011). Some authors used the concepts of complexity to inspect the influence of specific family interactions, such as dyadic problem-solving interactions, in children's and adolescent's healthy or maladjusted developmental pathways, making clear the importance of moment-to-moment family interactions and the emergent relational patterns in sustaining maladaptive behavioral patterns, on a longer developmental time-scale (Granic, 2005; Gramic & Lamey, 2002; Granic & Patternson, 2006). These studies clarify the dynamic relational mechanisms, operating at the different time-scales, linking different ecological systems and intraindividual and interindividual processes

(Granic, Dishion, & Hollenstein, 2003). Others used insights from coordination dynamics and DST to describe how patterns of motor development are softly assembled, and sustained, in the dynamic interactions of the systems' components (Thelen et al., 1991). Others, still, advocate and apply dynamic systems to model particular developmental processes (van Geert & Steenbeek, 2005) and interpersonal dynamics, such as those associated to successful couple relations (Gottman, Murray, Swanson, Tyson, & Swanson, 2002)

Notwithstanding these entire contributions share a DST orientation, there are differences far from being resolved in the way of understanding development and the ontological and epistemological implications of assuming a DST approach of development (Witherington & Margett, 2011).

In this paper, we choose to focus Complexity Science and not DST for a number of reasons. On the one hand, DST, although a basic mathematical language of Complexity, is only one of the multiple approaches integrated in the study of complex systems along with statistical physics, probability and information theory or network theory, to name a few examples (Érdi, 2008; Nicolis & Rouvas-Nicolis, 2007). On the other hand, although are different types of complexity (e.g. structural, informational) and different measures of complexity (Mitchell, 2009; Sporn, 2007), DST focuses mainly dynamical complexity. Dynamical complexity is a relevant issue to investigate in family development. However, its dissociation from structural complexity may result in an impoverished perspective of what changes and in what conditions during development. The denial of the necessary complementary relation between structure and function (Kelso, 1995; Kelso & EngstrØm, 2006) is, in fact, one of the critics addressed to some DST proposals in developmental research (Ellis & Bloch, 2011; Toomela, 2009; Witherington, 2011). Many of the above-mentioned authors have used DST to

look into particular dimensions of family relations or sub-systems and to describe and analyse them dynamically. But most of those studies have not been focused on the properties of the family as a complex system at the whole-family level.

A Complexity outlook may help us focus on that and attend to the structural, dynamical, and functional properties of the whole system. Complexity reminds us of the family's autonomy and of the uniqueness of a family system, notwithstanding the universality of self-organization processes.

We believe Family Science can use multiple contributions from Complexity Science in order to develop an integrated understanding of what is constituted at the emergence of a family, what and how it is transformed, in what circumstances and with what outcomes.

Contributions from Complexity to developmental family research

The emergence of the system we call a family

Several questions can be raised about what in a given system makes it a family, concerning how systemic properties are uniquely or commonly realized in it. We should ask what type of information is the most meaningful for the kind of coupling that transforms individual members into part of a family system. We should explore how coupling, a necessary condition for coordination in all living system (Kelso, 1995), is best defined in family systems and what rules govern it. We must also ask about the nature of family coupling (e.g. the information used, its dependence on differences or similarities between individuals, its strength and dynamics; its robustness) and how does it relate to the emergence of the family, its developmental processes and outcomes.

We believe two themes deserve special attention in investigating the emergence and development of a family system.

The first relates to where and how we find the system we want to study, namely how do we research the whole-family system (Cox & Paley, 1997, 2003). With the exception of studies using observational measures of interactional dimensions of family functioning, many research studies reply on self-report measures. These do not assess the family as a systemic entity but the individual's perception of it. This corresponds to a different level of analysis of what we believe needs to be fundamentally analysed in family developmental research. On the other hand, research studies focusing interactions at the whole-family level usually apply observational strategies to dyadic interactions and only with a few exceptions to more than two family members (Cox & Paley, 2003). We must inspect both the interactions between the individuals and their specific contributions, along with the boundary conditions constraining the emerging family patterns (Kelso & EngstrØm, 2006), but our focal coordination systemic level must be the whole-family.

The second theme relates to coupling as an essential condition for the emergence of the coordination patterns and the dynamics characterizing a complex system such as the family. We will briefly explore these two topics and possible research strategies inspired in Complexity concepts and methods.

The family is a multidimensional system with multiple coordinated patterns (e.g. family identity, family cohesion, family emotional climate). If we want to study family development we need to explore how these dimensions first appear, under what conditions they emerge and change and, then, how they exert top-down influences in the individuals. We should also understand how multiple dimensions coordinate among themselves. We should ask if there are any common features, or processes, sustaining these variables. We should look for higher-order, content-free, dimensions that encompass them all, allowing, therefore, a quicker and more throughout understanding

of the specific coordinative nature of the family as a system. To answer these questions we must look for variables that may be hard to identify (Kelso, 1995).

Therefore, there is a need to improve our methods and strategies to investigate the dimensions that the literature identifies as crucial to family adjustment, since we need to identify these dimensions as emergent family properties or coordination variables.

We believe we can borrow some insights and research strategies from Complexity, in particular from Synergetics (Haken, 1981, Tschacher & Haken, 2007), a field dedicated to explore self-organization, and Coordination Dynamics (CD) (Kelso, 1995; Kelso & Engstrom, 2006) which focuses coordination as an essential condition for self-organizing in living systems.

The relative phase is a measure of synchrony among the components of a system, first discovered in studies of motor coordination (Kelso, 1995). It simultaneously represents the coupling between the elements of a system and a coordination variable whose values predict different states of the system. This sort of coordination variable has a small number of states, making it a perfect candidate to understand the collective expression of a system. Similar variables have been found for neuronal, behavioural and interpersonal coordination (Fuchs & Jirsa, 2008; Oullier, de Guzman, Jantzen, Lagarde, & Kelso, 2008). Studies attending to synchronization, as a form of coordination, have proven useful also in psychotherapeutic studies, predicting therapeutic success (Ramsayer & Tschacher, 2011). Synchrony has also been explored in parent-infant dyads, with important implications for intervention (Feldman, 2012). Synchronization may be a strong candidate for a content-free coordination variable and may be applicable to different aspects of the interactions between individuals and the

different dimensions of family life, which need to be coordinated. Therefore, future research studies should take this concept as a point of departure.

Due to the centrality of coordination in self-organizing systems, the main question is not if coordination dynamics are worth exploring in family systems but what kind of coordination variables, patterns and dynamics, can be assessed and how. Finding core coordination variables applicable to different contents could allow us to look to different types of families with the same lenses without neglecting their differences, since their unique dynamics would be captured.

Let us consider family identity, as an example of a variable associated with positive family adaptation. To investigate it, at the family level, researchers need strategies to identify meaningful patterns of differences between the individual level and the family level. For example, researchers could ask family members to describe their family, during periods of stability and instability, both in separate moments and in joint interviews. Circular questioning techniques (Penn, 1982) could be used in those interviews to increase the richness of the data by capturing the coupling of each individual's position to the others. Through discovery-oriented qualitative analysis (Strauss, 1987), the researchers could try to uncover, on the one hand, differences in the individual's reports when alone or in the presence of other family members and, on the other, the similarities and differences between their reports as well as to identify the nature of the couplings between each other's positions. These strategies could bring the researcher closer to identifying coordinative information about the family as a system, for one particular dimension.

Another example of a research strategy inspired in studies of synchronization, suggests exploring the differences between the ratings in questionnaires or qualitative descriptions of the family members, concerning the coordination dimensions of interest.

Some quantification could be attempted concerning how much synchronized of unsynchronized the family members are in some given dimension of family functioning. Similar studies could use observation to compare the performance of a family member, in some given dimension of interest, when alone or when in the presence of other family (Cox & Paley, 2003). This kind of strategy is likely to produce useful information at the whole-family level and about the top-down influences which have been, somehow, neglected by DST research studies (Ellis & Bloch, 2011; Whitherington, 2011). Other contributions from Complexity could be explored in family research, for example from the field of network analyses or data-mining (Castellani & Hafferty, 2009), and combined with qualitative analysis, to assist the researcher in understanding the relation between different family dimensions.

Once we collect information at the appropriate level of analysis, we may also consider tracking the evolution of family coordination variables in time (van Geert & Lichtwarck-Aschoff, 2005).

Tracking the emergence and the transformation of such coordination variables may imply combining both retrospective and prospective longitudinal research methods. This could be done along with the exploration of coupling processes in order to understand how individuals coordinate different aspects of their individual existence (e.g. perceptions, emotions, feelings, thoughts, behaviour), how and when the multiple coordination dimensions of the family emerge. Intensive observations combined with interviews and other laboratory techniques could be used. Recently, advances in neuroimaging techniques allow researchers to explore brain-to-brain coupling (Dumas, 2011). Additionally, simpler psychophysiological records can be used to assess coordination between individuals (Oullier et al., 2008). This is certainly a new area for family science to explore in the future in order to clarify the mechanisms underlying

different levels of coupling (e.g. neurological, emotional, cognitive, behavioural) between family members.

Due to the importance of collecting rich and in-depth data, intensive, multi-method case studies are preferred strategies, for the purposes described in this article.

Another approach to study coordination in family systems would depart from the assumption that there may be relevant patterns of coordination that have not yet been fully untapped. Since coordination variables may be better identified during periods of greater fluctuations and bifurcations, studies with families facing multiple challenges should be preferred. Researchers should look for variables that simultaneously represent the coupling processes between family members, explain coordination between different family dimensions and the family's developmental processes and outcomes.

The kind of research programs we propose should first embrace an inductive-abductive approach and only later, when the rudiments of a theory of family coordination are organized and core variables are identified, should deductive, theory-driven studies be conducted.

Since historical, narrative and microgenetic methods have been successfully used to formulate theories of child development and dyadic interactions within a DST perspective (Fogel, 2011), their general methodology could be extended to the whole-family level. Longitudinal designs should be preferred although retrospective studies could sometimes be adequate to tap earlier stages of family development.

Methodologies should be diverse and take advantage of transition periods as privileged windows to understand the emergence of dynamic patterns and then its pattern dynamics, through resource to dynamical methods and dynamical systems theory (Kelso & Engstrom, 2006; Valsiner, Molenaar, Lyra, & Chaudhary, 2009)

Coordination variables, although not easy to find, may become evident by their explanatory power.

The complexity of a family system

If we assume the family as complex system we may question how to identify complexity at the whole-family level. Could complexity be, simultaneously, a developmental process and outcome (Lerner, 2002; Rathunde & Csikszentmihalyi, 2006)? Could family complexity be, after all, that which develops in family development? Could the concept of complexity account for the diversity of family forms and developmental outcomes?

A first theoretical challenge would be to define family complexity and to understand on which type of data it could be grounded. Empirically, it would be necessary to operacionalize adequate measures of complexity and test whether they could be applicable to different domains of family functioning, independently of their content, and to their coordination.

Measures of complexity often balance the amount of order and disorder in an open system (Sporns, 2007). Edelman and Tononi (2000, p. 130-131) state, in regard to brain complexity that "high values of complexity correspond to an optimal synthesis of functional specialization and functional integration within a system". Definitions of developmental complexity, based on the concepts of differentiation and integration, are also proposed in developmental science (Lerner, 2002). Content-free definitions of complexity could be adapted for family research (Fischer & Bidell, 2006) to explore vertical integration and horizontal differentiation in the family and its multiple dimensions. Using the example of family identity, we could study how differentiated and integrated this construction is and how well it is integrated with other dimensions of family functioning. Researchers could, for example, explore how reports from the

family accommodate diverse qualifiers and in what extent they compose a coherent sense of family identity. We hypothesize that the more complex (the more differentiated and integrated) the sense of family identity the more the family will find in it orientation to deal with different types of challenges, to regulate its internal relations and the relation to its environment, at the family-level, as expected from the complex individual (Rathunde & Csikszentmihalyi, 2006)

Hierarchy, as a consequence of integration, is a common feature in complex systems. When applied to the family, hierarchy is understood, almost exclusively, in terms of sub-systems. But the family sub-systems may be poor indicators of the family's complexity. They are more like convenient categories for an observer to make sense of the family than truly expressions of its emergent complexity or self-organization. They are properties of observer more than the system itself. We may argue that every act of description and explanation is a creation of an observer but if we position ourselves within a Complexity perspective we would need to look to the family in search for indicators of self-organizing activity and emergence. In our opinion, the introduction of new family members can contribute to a greater complexity in the family in terms of the number of family dimensions that define it, and their own differentiation and integration, without being, necessarily, an expression of it. It may be associated with changes leading to greater complexity because of the perturbation it introduces in the interactions between family members. The complexity of the family dimensions or coordination variables at the whole-family level, emerging from these interactions, is probably a best criterion for the definition of different phases of family development, than the number of family members or sub-systems. Different phases of increasing complexity would succeed as the family dimensions gains new expressions, and to the extent that there are qualitative transformations, or phase transitions, which

allow the family to use them in different ways, augmenting its possibilities of action both within the family realm and in the interactions with its milieu.

Using some measure of family complexity as a marker of family development seems more congruent with a complex systems' than the criterion of the life-cycle perspectives. Additionally, a conceptualization of family development based in its complexity has the potential to apply to a great diversity of families and inform comparative studies without denying their unique structural and dynamical features.

Conclusion

In this article, we affirm the need to stimulate a new debate about how to conceptualize family development in the 21st century in order to capture the essence of the system we call a family, while respecting the diversity of family forms. We reinforce the need to investigate developmental dynamics at the proper whole-family system level. We propose that these tasks can be accomplished with fruitful theoretical and methodological contributions from Complexity Sciences. Complexity's core concepts and research methods can help family researchers raise new research questions and conduct theoretical and empirical research endeavors with a focus on the family as an emergent domain of coordination. We also propose that the concept of family complexity, if thoroughly explored, may embrace the "real-world" complexity of families in the 21st and contribute to a new level understanding of family development. In the end, we hope to stimulate new theoretical debates and the exploration of new approaches to the study of family development.

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