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Individual Differences: Interplay of Learner Characteristics and Learning Environment

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The notion of language as a complex adaptive system has been conceived within an agent-based framework, which highlights the significance of individual-level variation in the characteristics and contextual circumstances of the learner/speaker. Yet, in spite of this emphasis, currently we know relatively little about the interplay among language, agent, and environment in the language acquisition process, which highlights the need for further research in this area. This article is intended to pursue this agenda by discussing four key issues in this respect: (a) conceptualizing the agent, (b) conceptualizing the environment and its relationship to the agent, (c) operationalizing the dynamic relationship among language, agent, and environment, and (d) researching dynamic systems.

In their position paper, the "Five Graces Group" (this issue; henceforth FGG) proposed that the complex adaptive system (CAS) of language should be conceived within an *agent-based* framework, in which "different speakers may exhibit different linguistic behavior and may interact with different members of the community (as happens in reality)." This highlights the significance of individual-level variation in the characteristics and contextual circumstances of the learner/speaker. Accordingly, a key principle of the proposed approach is that from the point of view of language acquisition and behavior, the interaction between the language learner/user and the environment matters. This, of course, is in stark contrast to the traditional approach of generative linguistics dominating the second half of the 20th century, for which the cognitive system underlying language was conceptualized as largely context and user independent.

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In the light of the above, a curious feature of the FGG paper is that in spite of the emphasis on the agent-based framework, there is very little said about the agent, and even the discussion of the role of the environment is limited to highlighting a few selected points only, such as social networks or the language input generated by the learner's social experience. It is clear that further research is needed to elaborate on the interplay among language, agent, and environment, and the current article is intended to pursue this agenda by discussing four key areas in this respect: (a) conceptualizing the agent, (b) conceptualizing the environment and its relationship to the agent, (c) operationalizing the dynamic relationship among language, agent, and environment, and (d) researching dynamic systems.

Conceptualizing the Agent

Learner characteristics in applied linguistics have traditionally been investigated within the context of *individual differences* (IDs), which are conceived to be attributes that mark a person as a distinct and unique human being. Of course, people differ from each other in respect of a vast number of traits, of which ID research has traditionally focused only on those personal characteristics that are enduring, that are assumed to apply to everybody, and on which people differ by degree. In other words, ID factors concern stable and systematic deviations from a normative blueprint (Dörnyei, 2005).

Individual differences have been well established in SLA research as a relatively straightforward concept: They have usually been seen as background learner variables that modify and personalize the overall trajectory of the language acquisition processes; thus, in many ways, IDs have been typically thought of as the systematic part of the background "noise" in SLA. Particularly, four ID factors have received special attention in past second language (L2) research (see, e.g., Dörnyei, 2005; Dörnyei & Skehan, 2003; Robinson, 2002a; Skehan, 1989): *motivation, language aptitude, learning styles*, and *learning strategies*. Broadly speaking, *motivation* was seen to concern the affective characteristics of the learner, referring to the direction and magnitude of learning behavior in terms of the learner's choice, intensity, and duration of learning. *Language aptitude* determines the cognitive dimension, referring to the capacity and quality of learning. *Learning styles* refer to the manner of learning, and *learning strategies* are somewhere in between motivation and learning styles by referring to the learner's proactiveness in selecting specific made-to-measure learning routes. Thus, the composite of these variables has been seen to answer

why, *how long, how hard, how well, how proactively,* and *in what way* the learner engages in the learning process.

In a recent overview of the psychology of SLA, I have proposed (Dörnyei, 2009) that the seemingly comprehensive and straightforward picture of IDs being stable and monolithic learner traits that concern distinct learner characteristics is part of an idealized narrative that may not hold up against scientific scrutiny. The core of the problem is that if we take a situated and process-oriented perspective of SLA, we cannot fail to realize that the various learner attributes display a considerable amount of variation from time to time and from situation to situation. Indeed, one of the main conclusions of my 2005 review of individual differences (Dörnyei, 2005) was that the most striking aspect of nearly all the recent ID literature was the emerging theme of *context*:

> It appears that cutting-edge research in all these diverse areas has been addressing the same issue, that is, the situated nature of the ID factors in question. Scholars have come to reject the notion that the various traits are context-independent and absolute, and are now increasingly proposing new dynamic conceptualizations in which ID factors enter into some interaction with the situational parameters rather than cutting across tasks and environments. (p. 218)

Thus, language aptitude, for example, has been found to impact different tasks and learning contexts differently (e.g., Robinson, 2007), and motivation usually shows considerable ongoing fluctuation with regular ebbs and flows (e.g., Dörnyei, 2000). More generally, most ID researchers would now agree that the role of learner characteristics can only be evaluated with regard to their interaction with specific environmental and temporal factors or conditions. In their recent analysis of SLA, Ellis and Larsen-Freeman (2006, p. 563) summed up this issue as follows: "To attribute causality to any one variable (or even a constellation of variables) without taking time and context into account is misguided." This view is also supported by the results of genetics research, which reveal that not even our inherited genes are context independent but exert their influence through their interaction with the environment: According to Bouchard and McGue (2003), for example, genetic influences account for approximately 40–55% of the variance in personality and Modell (2003) explained that environmental influences make the brains of even identical twins appreciably different.

Thus, ID effects cannot be identified accurately without taking into account the idiosyncratic features of the specific temporal and situational context we are investigating, and the picture gets even more complicated with the recognition

that rather than being monolithic, most learner characteristics are complex, higher order mental attributes, resulting from the integrated operation of several subcomponents and subprocesses. Indeed, higher order ID variables such as aptitude and motivation involve, at one level or another, the cooperation of components of very different nature (e.g., cognitive, motivational, or emotional), resulting in "hybrid" attributes.

A good illustration of this componential mixture has been provided by a recent study by Dörnyei and Tseng (2009), which examined the question of motivational task processing by empirically testing a theoretical model that I proposed in 2003 (Dörnyei, 2003). As I suggested then, the motivational dynamics of learning tasks is dependent on how the participating learners process the various motivational stimuli they encounter and, as a result, how they activate certain necessary motivational strategies. The construct suggests that L2 learners are engaged in an ongoing appraisal and response process, involving their continuous monitoring and evaluating how well they are doing in a task and then making possible amendments if something seems to be going amiss. This process can be represented through a dynamic system that consists of three interrelated mechanisms: "task execution," "appraisal," and "action control."

Task execution refers to the learners' engagement in task-supportive learning behaviors in accordance with the task goals and the action plan that were either provided by the teacher (through the task instructions) or drawn up by the student or the task team. In other words, this is the level of actual "learning." *Task appraisal* refers to the learner's continuous processing of the multitude of stimuli coming from the environment regarding the progress made toward the action outcome, comparing the actual performance with the predicted or hoped-for ones or with the likely performance that alternative action sequences would offer. *Action control* processes denote self-regulatory mechanisms that are called into force in order to enhance, scaffold, or protect learning-specific action; active use of such mechanisms may "save" the action when ongoing monitoring reveals that progress is slowing, halting, or backsliding.

Dörnyei and Tseng's (2009) validation study involved a structural equation modeling (SEM) analysis of the proposed construct and has confirmed a circular relationship of the three components (see Figure 1): Signals from the appraisal system concerning task execution trigger the need to activate relevant action control strategies, which, in turn, further facilitate the execution process. An example of this process would involve someone, say Martin, listening to a rather boring lecture and noticing that his concentration is flagging. This recognition, in turn, initiates a search in his repertoire of relevant action control

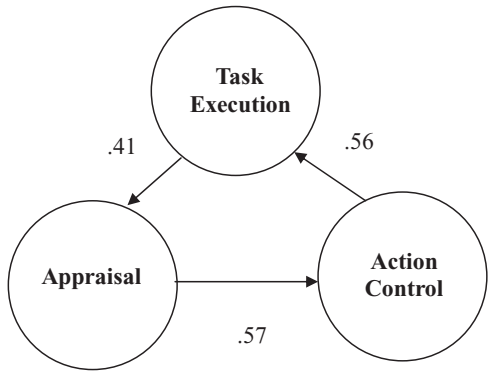

Figure 1 Structural equation diagram of motivational task processing (from Dörnyei & Tseng, 2009).

or self-motivating strategies, and if Martin finds a way that would help him to refocus his attention (e.g., reminding himself of the significance of the topic or of the need to listen or else he will not be able to write a required report of the content of the presentation), then he executes this troubleshooting strategy, thereby restoring the necessary level of attention. Thus, a process that is primarily motivational in nature relies on a cognitive appraisal component. This is in fact not an uncommon combination, as most theoretical conceptualizations of emotion, for example, contain a cognitive appraisal component that is responsible for the evaluation of the situation that evokes an emotional response (Lewis, 2005).

Addressing this issue more generally, Dörnyei (2009) provided a detailed argument that given the complex and interlocking nature of higher order human functioning, individual differences in mental functions typically involve a blended operation of cognitive, affective, and motivational components—a convergence that becomes even more obvious if we take a neuropsychological perspective, because at the level of neural networks it is difficult to maintain the traditional separation of different types of functions. The question, then, is whether in this light there is any justification for proposing any macrostructuring principles to individual variation in human mental functions (such as "cognitive" or "motivational" functions)?

I believe that there is one perspective according to which the main types of mental functions can be separated: the *phenomenological* (i.e., experiential) view: People can phenomenally distinguish three areas of mental functioning—*cognition*, *motivation*, and *affect* (or emotions)—which is, in fact, a traditional

division going back to Greek philosophy, often referred to as the "trilogy of the mind" (see Mayer, Chabot, & Carlsmith, 1997). Plato proposed that the human soul contained three components: *cognition* (corresponding to thought and reason and associated with the ruling class of philosophers, kings, and statesmen), *emotion/passion* (corresponding to anger or spirited higher ideal emotions and associated with the warrior class), and *conation/motivation* (associated with impulses, cravings, desires and associated with the lower classes) (for a review, see Scherer, 1995).

I believe that it is useful to maintain this tripartite view and think of these three dimensions of the mind as three subsystems. However, it is also clear that the three subsystems have continuous dynamic interaction with each other and cannot exist in isolation from one another; as Buck (2005, p. 198) put it: "In their fully articulated forms, emotions imply cognitions imply motives imply emotions, and so on." Therefore, I have argued (Dörnyei, 2009) that instead of conceptualizing learner characteristics in a modular manner (i.e., in terms of distinct ID factors), future research should try and take a systemic approach by identifying higher level amalgams or constellations of cognition, affect, and motivation that act as "wholes." Two examples of such composite factors in SLA research are Robinson's (2002b, 2007) notion of *aptitude complexes* and Dörnyei's concept of *ideal and ought-to selves* (e.g., Dörnyei, 2005, 2009).

Conceptualizing the Environment and Its Relationship With the Agent

The FGG paper clearly states that "Language has a fundamentally social function" and reiterates later that "Language is used for human social interaction, and so its origins and capacities are dependent on its role in our social life." Indeed, currently most scholars would agree that the individual's experience in the social environment affects every aspect of human functioning, including language acquisition and use. This is in fact a relatively old issue, going back to at least the 1930s; as Funder (2006) has summarized in a recent article devoted to the analysis of the personal and situational determination of behavior,

> Since at least the 1930s, deep thinkers as diverse as Allport (1937) and Lewin (1951) have argued that invidious comparisons miss the point because behavior is a function of an interaction between the person and the situation. By the 1980s this recognition had deteriorated into a truism. Nowadays, everybody is an interactionist. (p. 22)

In spite of this seeming agreement, the social issue is a hotbed of disagreement and debates. In psychology, this dispute has often been referred to as the "person situation debate," and a recent Focus Issue of *The Modern Language Journal* (Lafford, 2007) has articulated well the tension between cognitive and social agendas in applied linguistics (for good summaries of the cognitive-social debate, see Larsen-Freeman, 2007b; Zuengler & Miller, 2006). Thus, we seem to have a curious situation whereby everybody appears to agree with certain general principles, and yet when these principles are put into practice, the issue becomes oddly divisive.

One of the main reasons for the divergent views is, I believe, the challenge of conceptualizing the environment and its relationship with the agent in particular. In psychology, the field specialized in the study of how the individual interacts with the surrounding social world is *social psychology*. This field has been deeply divided by a basic disagreement about how to approach the issue of the individual embedded in society: from the individual's or from the society's perspective (for an overview, see Abrams & Hogg, 1999). The *individualistic perspective*—best represented by the "social cognition" paradigm—considers the social or cultural context through the individual's eyes. Accordingly, the complexity of the social environment is only important inasmuch as it is reflected in the individual's mental processes and the resulting attitudes, beliefs and values; that is, the focus is on how people process social information and make sense of social situations. This perspective, therefore, offers a cognitive representation of the social world.

In contrast, the *societal perspective*—best represented by "social identity" theory—focuses on broad social processes and macro-contextual factors, such as sociocultural norms, intergroup relations, acculturation/assimilation processes, and cross-cultural or interethnic conflicts. From this perspective, the individual's behavior is seen to be largely determined by the more powerful forces at large; that is, social identity is often seen to override personal identity as exhibited, for example, by the individual's submission to normative pressures imposed by specific reference groups of cultural expectations.

This individual-societal tension can be seen as a good reflection of the inherent challenge of relating the agent to the environment in a coherent theoretical or research framework. For example, within the context of quantitative research, Byrne (2002, p. 9) explained that "Conventional statistical reasoning in the social sciences is incapable of dealing with relationships among levels—or relating individuals to social collectivities—other than by regarding social collectivities as mere aggregates of individuals with no emergent properties." The individualistic-societal contrast also manifests itself clearly in

the often mixed selection of variables, metaphors, and research approaches to link the agent and the environment. The FGG paper mentions, for example, the learner/speaker's "prior experience," which is at the individualistic end of the cline, and the learner's position in a "social network structure," which is further toward the societal end. Else, as the abstract of the paper summarizes, "A speaker's behavior is the consequence of competing factors ranging from perceptual constraints to social motivations," which, again, reflects a prominent individual-social contrast. There is, in fact, a great variety of approaches along the individualistic-societal cline, depending on how we identify and select the relevant environmental factors to be integrated in a particular research paradigm. In this respect, Funder (2006) drew attention to the specific difficulty of identifying the key parameters of the "social situation":

> it is difficult to pin down just how situations are important, in part because of the common but unilluminating practice of assigning "the situation" responsibility for all the behavioral variance not accounted for by a particular personality trait, *without* specifying what aspects of the situation are psychologically essential. There is a good deal of confusion concerning how situations should be conceptualized. (p. 27)

A good illustration of the confusing complexity that Funder is talking about is offered by the way one of the main types of instructional contexts—the "classroom situation"—has been theorized in educational psychology. As Turner and Meyer (2000) summarized, classroom environments have been variously studied in terms of the "beliefs, goals, values, perceptions, behaviors, classroom management, social relations, physical space, and social-emotional and evaluative climates that contribute to the participants' understanding of the classroom" (p. 70). Furthermore, it is common to distinguish at least two broad dimensions of the classroom environment: the "instructional context," which concerns the influences of the teacher, students, curriculum, learning tasks, and teaching method, among other things, and the "social context," which is related to the fact that the classroom is also the main social arena for students, offering deeply intensive personal experiences such as friendship, love, or identity formation. These two contexts are interdependent and also interact with the complex process of learning.

In the study of SLA, there have been several initiatives to situate research and thus capture environmental effects, for example in classroom ethnography (e.g., Harklau, 2005; Toohey, 2008; Watson-Gageo, 1997), the microanalysis of classroom discourse (e.g., Zuengler & Mori, 2002), the interaction hypothesis (e.g., Gass, 2003; Gass & Mackey, 2007; Mackey & Polio, 2009), the group

dynamics of language learning and teaching (e.g., Dörnyei & Murphey, 2003; Ehrman & Dörnyei, 1998), sociocultural theory (e.g., Lantolf & Thorne, 2006), and language socialization (e.g., Schieffelin & Ochs, 1986; Watson-Gegeo, 2004; Zuengler & Cole, 2005). In fact, even the general issues of language instruction and how language input becomes intake concern the interaction of the learner and the environment.

In sum, the availability of diverse multiple approaches to conceptualizing the environment relative to the agent indicates the inherent difficulty of establishing a parsimonious system of valid and generalizable parameters to describe contextual characteristics. Therefore, challenge for future research is to find ways of identifying the key factors determining the joint operation of the agent-environment dyad. In Larsen-Freeman's (2007a, p. 37) words, "The answer, I believe, lies in finding the optimal interconnected units of analysis depending on what we are seeking to explain." Additionally, as she elaborates, the challenge will lie in "cultivating a dialectical relation between parts and wholes in order to identify the appropriate functional units of analysis, which is of course something that is likely to require ongoing redefinition, depending on the inquiry." Because different aspects of the agent's development are possibly affected by different aspects of the environment, the initial understanding of the agent-environment link is likely to be established primarily through exploratory qualitative investigations, a question I will come back to in the last section of this article.

Operationalizing the Dynamic Relationship Among Language, Agent, and Environment

A basic principle of the CAS approach in the FGG paper is that the process of language acquisition and use is taken to be *dynamic*. The term "dynamic" is used here in a specific sense, as a technical term to signify the relevance of *complexity theory* and two trends within this broad approach—*dynamic systems theory* and *emergentism*. These approaches share in common their central objective of describing development in complex, dynamic systems that consist of multiple interconnected parts and in which the multiple interferences between the components' own trajectories result in nonlinear, emergent changes in the overall system behavior (for overviews, see, e.g., de Bot, 2008; de Bot, Lowie, & Verspoor, 2007; Dörnyei, 2009; Ellis & Larsen-Freeman, 2006; Larsen-Freeman & Cameron, 2008a; van Geert, 2008). Ellis (2007, p. 23) argued that from this dynamic view language can be seen as a

> complex dynamic system where cognitive, social and environmental factors continuously interact, where creative communicative behaviors emerge from socially co-regulated interactions, where there is little by way of linguistic universals as a starting point in the mind of *ab initio* language learners or discernable end state, where flux and individual variation abound, where cause-effect relationships are nonlinear, multivariate and interactive, and where language is not a collection of rules and target forms to be acquired, but rather a by-product of communicative processes.

Complex, dynamic systems are in constant interaction with their environment, so much so that the context is seen as part of the system, with neither the internal development of the organism nor the impact of the environment given priority in explaining behavior and its change. Equilibrium in this sense means a smooth, ongoing adaptation to contextual changes (Larsen-Freeman & Cameron, 2008a). The following summary by de Bot et al. (2007) provides a good illustration of the intricacy of this dynamic conceptualization:

> a language learner is regarded as a dynamic subsystem within a social system with a great number of interacting internal dynamic sub-sub systems, which function within a multitude of other external dynamic systems. The learner has his/her own cognitive ecosystem consisting of intentionality, cognition, intelligence, motivation, aptitude, L1, L2 and so on. The cognitive ecosystem in turn is related to the degree of exposure to language, maturity, level of education, and so on, which in turn is related to the SOCIAL ECOSYSTEM, consisting of the environment with which the individual interacts. . . . Each of these internal and external subsystems is similar in that they have the properties of a dynamic system. They will always be in flux and change, taking the current state of the system as input for the next one. (p. 14)

Such a complex setup is admittedly not easy to work with and our natural tendency has been to focus on selected aspects of the system such as the nature of input, particular learner characteristics, or some social aspect of the environment and then examine the system outcome (e.g., language attainment) in this particular light. De Bot et al. (2007), however, warned that such accounts will provide a gross oversimplification of reality, because only the integrated consideration of all factors can form an appreciation of the actual complexity. Although this might be true, the authors also add that "it is a matter of fact that it is very difficult to get a grip on complex interactions" (p. 18).

Interestingly, even Larsen-Freeman and Cameron (2008a), who have written a whole book on complexity theory, admitted that developing the new

perspective has posed a real language challenge, as it is "easy to fall back into old ways of thinking, and requires continual monitoring to ensure that ways of talking (or writing) reflect complex dynamic ways of thinking" (p. x). One important factor that may explain why it is relatively easy to become complacent about describing the language system in sufficiently dynamic terms is that although there are several aspects of first language (L1) acquisition that point to the relevance of a dynamic, emergent systems approach, the existence of some powerful forces—or in dynamic systems terms, *attractors*—appear to override much of this dynamic variation, to the extent that L1 acquisition is one of the most homogeneous and predictable of all the higher level cognitive processes. Indeed, *in spite of* all the individual differences and experience-based variation, L1 speakers uniformly master their mother tongue to an extent that they become indistinguishable from other members of the L1 community in terms of their language-based membership (which is often referred to as being a *native speaker*). Furthermore, we find robust, predictable tendencies even with regard to social and regional stratification, such as accents and dialects. In short, we can go a long way in analyzing and understanding L1 phenomena without having to take the system dynamics into account.

However, coming from a SLA background—like I do—one becomes more alert to dynamic variation, because one of the main differences between L1 and L2 acquisition is the significantly increased variability of the latter process. Without any doubt, L2 development is far more exposed to the impact of system complexity than mother-tongue learning, which is reflected in the heterogeneity of the (typically limited) end state of adult learners' language attainment. When discussing SLA, we simply cannot provide adequate explanations without considering a number of learner-based or environmental factors such as the learner's age and motivation or the amount and nature of instructional language input.

Researching Dynamic Systems

The final challenge in giving the language-agent-environment dynamics its due importance is related to the general uncertainty in the social sciences about how to conduct empirical studies in a dynamic systems vein. The FGG paper recognizes this issue very clearly: "In the various aspects of language considered here, it is always the case that form, user, and use are inextricably linked. But such complex interactions are difficult to investigate in vivo." Indeed, there are obvious problems with (a) modeling nonlinear, dynamic change (especially quantitatively), (b) observing the operation of the whole system and the interaction of the parts rather than focusing on specific units in it, and

(c) replacing conventional quantitative research methodology and statistics with alternative methods and tools (Dörnyei, 2009). In a recent article examining the research methodology on language development from a complex systems perspective, Larsen Freeman and Cameron (2008b, p. 200) summarized this issue as follows: "The dynamic, nonlinear, and open nature of complex systems, together with their tendency toward self-organization and interaction across levels and timescales, requires changes in traditional views of the functions and roles of theory, hypothesis, data, and analysis."

Thus, measuring the state of dynamic systems with precision is not at all straightforward, particularly in the light of Byrne's (2002, p. 8) assertion: "If we think of the world as complex and real we are thinking about it in a very different way from the ontological program that underpins conventional statistical reasoning and cause." Unfortunately, complexity/dynamic systems research in the social and cognitive sciences is a relatively uncharted territory and, therefore, currently we have only few research methodological guidelines on how to conduct language-specific dynamic systems studies. Key research issues in this respect, listed by Dörnyei (2009), include the following (for a detailed overview, see Larsen-Freeman & Cameron, 2008b):

- *Cause-effect relationships.* Within a dynamic systems framework there are no simple cause-effect explanations between variables examined in isolation, which is the standard research focus in most applied linguistic research, particularly in the area of individual differences. Thus, rather than pursuing such a reductionist agenda, studies in the dynamic systems vein need to emphasize the processes of self-organization with regard to the whole of the interconnected system. Byrne (2005) summarizes this issue very clearly:

  > Arguments for complexity are not arguments against simplicity. Some things can be understood by the analytic and reductionist program and where that program works it has done great service in elucidating causality. The problem is that it works where it works and it does not work everywhere. Indeed in a natural/social world the range of its applicability is rather limited. The problem is that, instead of the application of the simple model being understood as something that always has to be justified by showing that what is being dealt with can be analyzed, the simple model is taken as 'the scientific model', which is always applicable. The dominant contemporary modes of statistical reasoning in the social sciences are a particular example of this (see Byrne, 2002). (pp. 101–102)

- *Qualitative rather than quantitative approach.* Although complexity/dynamic systems theory has an extensive mathematical basis in applications in the natural sciences, a dynamic systems approach in SLA does not lend itself easily to quantitative investigations, because the number of confounding variables is extensive and some of them cannot be measured at the level of precision that is required for mathematical analyses. On the other hand, several aspects of *qualitative research* make this approach suited to complexity/dynamic systems studies because of (a) the emergent nature of data collection and analysis, (b) the thick description of the natural context, (c) the relative ease of adding longitudinal aspects to the research design, and (d) the individual-level analysis that helps to avoid the potential problem that the results derived from a group of learners are unlikely to correspond to the unique dynamic patterns characterizing the individual participants.
- *Mixed methods research*. I have argued elsewhere (Dörnyei, 2007) that *mixed methods research* (i.e., the meaningful combination of qualitative and quantitative approaches) offers a radically different new strand of research methodology that suits the multilevel analysis of complex issues, because it allows investigators to obtain data about both the individual and the broader societal context.
- *Focus on change rather than variables.* Social scientists tend to focus on well-defined and generalizable *variables* to describe the social world around them. A complexity/dynamic systems approach needs to shift the emphasis from this variable-centered, reductionist practice to studying how systems *change* in time. As van Geert (2008, p. 197) summarized, "an understanding of dynamic systems is crucial if we want to go beyond the static or structural relationships between properties or variables and wish to understand the mechanism of development and learning as it applies to individuals."
- *Longitudinal research.* In his influential book on longitudinal research, Menard (2002) argued that longitudinal research should be seen as the default when we examine any dynamic processes in the social sciences. Such dynamic processes are obviously involved in human learning/growth or social change, but they can also be associated with various interactions of different levels of an issue (e.g., micro or macro) or of different types of variables (e.g., learner traits and learning task characteristics). Indeed, it is difficult to imagine a dynamic systems study that does not have a prominent longitudinal aspect.
- *Focus on system modeling.* Modeling is an important aspect of complexity/dynamic systems theory because it considers, by definition, the

coordinated operation of the whole system and allows for various cyclical processes, feedback loops, and iterations. However, as mentioned earlier, drawing up quantitative models of complex systems may not only be mathematically too demanding but arguably also unrealistic and inadequate for cognitive and social systems (van Gelder & Port, 1995). Larsen-Freeman and Cameron (2008a) described an interesting *qualitative modeling* approach that they call "complexity thought modeling," comprising a series of steps: (a) identifying the different components of the system, (b) identifying the timescales and levels of social and human organization on which the system operates, (c) describing the relations between and among components, (d) describing how the system and context adapt to each other, and (e) describing the dynamics of the system—that is, how the components and the relations amongst the components change over time.

Conclusion

The starting point of this article was the observation that even though the FGG paper emphasizes an agent-based framework for the study of language as a complex adaptive system, it offers few specific details about the agent's role in the language acquisition process. In explaining this situation, I suggested that, currently, the dynamic interaction among language, agent, and environment is rather undertheorized and underresearched. I discussed four areas in particular where we face certain conceptual challenges with regard to doing the language-agent-environment relations justice in the study of L1 and L2 acquisition: conceptualizing the agent; conceptualizing the environment and its relationship to the agent; operationalizing the dynamic relationship among language, agent, and environment; and, finally, researching dynamic systems.

With respect to the analysis of the agent, I pointed out that applied linguistics (and educational psychology in general) has typically followed an individual difference-based approach to integrate learner characteristics into the various research paradigms. However, the traditional notion of individual difference factors, conceived as stable and monolithic learner characteristics, is outdated because it ignores the situated and multicomponential nature of these higher order attributes; the study of such complex constellations of factors requires a dynamic systems approach. If this argument is correct, then, identifying "pure" individual difference factors has only limited value both from a theoretical and a practical point of view. Instead, a potentially more fruitful approach is to focus on certain higher order combinations of different attributes that act as integrated wholes.

Understanding the functioning of the agent in the language learning process is further complicated by the fact that humans are social beings, and in an inherently social process such as language acquisition/use, the agent cannot be meaningfully separated from the social environment within which he/she operates. The significance of contextual influences has become a hot topic in several fields within the social sciences and, accordingly, conceptualizing situated constructs and research paradigms has become the dominant tendency in virtually all of contemporary SLA research. The challenge, then, is to adopt a dynamic perspective that allows us to consider simultaneously the ongoing multiple influences between environmental and learner factors in all their componential complexity, as well as the emerging changes in both the learner *and* the environment as a result of this development. This latter aspect is critical because, as Ushioda (2009) pointed out, context is generally defined in individual difference research as an independent background variable, or a static backdrop, over which the learner has no control. Such a conceptualization, Ushioda argued, sustains the basic Cartesian dualism between the mental and the material worlds, between the inner life of the individual and the surrounding culture and society. A truly dynamic systems approach will need to bridge this gap between the inner mental world of the individual and the surrounding social environment.

Although a dynamic systems approach would offer obvious benefits for the study of the complex interaction of language, agent, and environment, operationalizing this dynamic relationship in specific theoretical and measurement terms takes us into rather uncharted territories, with few specific guidelines or templates currently available to follow. In a position paper in *Developmental* Review championing dynamic systems approaches, Howe and Lewis (2005) explained the reasons why dynamic systems approaches to development remain a clear minority as follows:

> There has been a great deal of complaining in developmental journals about the constraints of conventional developmental approaches, including static or linear models and the use of averages rather than time-sensitive process accounts, and many developmentalists have espoused the value of systems thinking in theoretical articles. Yet most developmentalists continue to use conventional experimental designs and statistics to carry out their research. We think this is because the trajectory of developmental psychology, like other dynamic systems, tends toward stability much of the time. Researchers stick to well-established habits of thinking and working, and their students acquire the same habits, often

> because that is the easiest road to publication and career advancement. (p. 250).

However, I would like to believe that the absence of ready-made research models and templates is not an indication of the inadequacy of a dynamic approach but only of the transitional problems that are bound to accompany a major paradigm shift. After all, I hope I am not alone in sharing Thelen and Smith's (1994, p. 341) experience:

> Once we began to view development from a dynamic and selectionist approach, we found the ideas so powerful that we could never go back to other ways of thinking. Every paper we read, every talk we heard, every new bit of data from our labs took on new meaning. We planned experiments differently and interpreted old experiments from a fresh perspective. Some questions motivating developmental research no longer seemed important; other, wholly new areas of inquiry begged for further work.

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