



## Introduction to Special Section

## The developmental neuroscience of adolescence: Revisiting, refining, and extending seminal models



*Adolescence is when the very worst and best impulses in the human soul struggle against each other...*

–G. Stanley Hall (1904)

*Adolescence is not for the faint of heart.*

*The to-do list . . . includes separating from your parents,*

*finding your place among your peers. . .*

*[making] decisions about your own future,*

*and—oh yes—figuring out how to relate to the world,*

*and yourself, as a suddenly and mystifyingly sexual being.*

–Dana Stevens

*Make everything as simple as possible,*

*but not simpler.*

–Albert Einstein

Adolescent development involves a complex set of interrelated biological, behavioral, psychological, and social processes. Since 1904, when G. Stanley Hall first published his two-volume magnum opus ***Adolescence, Its Psychology and its Relations to Physiology, Anthropology, Sociology, Sex, Crime, Religion, and Education***—in what is widely recognized as the beginning of the scientific focus on adolescence—the field has struggled with the sheer complexity inherent in understanding this important period of human development.

The fundamental challenge, scientifically, is how to simplify, but not to *over-simplify*. On the one hand, scientific progress requires parsing complexity, ideally into falsifiable hypotheses that can be addressed within well-designed empirical studies. On the other hand, slicing too narrowly is likely to miss important aspects of these multi-faceted developmental processes, unlikely to achieve a depth of understanding of the real-world complexities relevant to the unique risks and opportunities impacting youth during this maturational period.

Conceptual and heuristic models play a crucial role in finding a working balance. Ideally the right kind of models allow us to grapple with large and important complexities of interest, while also providing frameworks for testing (simpler) key features of the models, to advance the science.

Over the past 15 years, there have been rapid advances in developmental cognitive, affective, and social neuroscience approaches to understanding adolescence. These pioneering advances have further amplified the need for new models. The levels of complexity are *increasing*—not only regarding the biological processes,

including the neural circuitry and underlying molecular processes involved in development and learning—but also regarding the complex interactions *between* social contexts and the developing biological systems. There also has been a great deal of progress in understanding the cognitive, emotional, psychological, and social aspects of adolescent development and their relationships to neurobehavioral development.

Finally, there has been enormous progress in understanding the *importance* of adolescence as a period of vulnerabilities and opportunities relevant to a wide range of outcomes—in ways that have lifelong impact on physical and mental health, education, well-being, and social as well as economic success. Thus, the stakes for achieving a deeper scientific understanding of these complex developmental processes have never been higher.

Taken together, this combination of growing complexities, increased capacities and tools for making scientific progress, and increased stakes for understanding the complex real-world issues, create a *compelling need to develop and refine useful heuristic models* focusing on brain and behavioral development during adolescence.

The papers and commentaries in this special section are well aligned with these goals. Among the most influential early models relevant to these issues were: (a) the Social Re-orientation/Social Information Processing Model (Nelson et al., 2005); and (b) a set of dual-systems/imbalance models (Steinberg et al., 2006, 2008; Steinberg, 2008; Casey et al., 2008).

This special section focuses on two important and interesting reviews that revisit and update these early seminal models:

***The Dual Systems Model: Review, Reappraisal, and Reaffirmation*** by Shulman, Smith, Silva, Icenogle, Duell, Chein, & Steinberg (this issue).

***Social Re-orientation and Brain Development: an Expanded and Updated View*** by Nelson, Jarcho, & Guyer (this issue).

Each paper provides a thoughtful reevaluation of current understanding in the light of the large number of empirical studies and progress over the past several years, and each considers some updates and refinements from the earlier models.

This special section also includes four invited commentaries: ***Beyond Simple Models of Adolescence to an Integrated Circuit-Based Account:***

***A Commentary*** by Casey, Galvan & Somerville.

***Developing Developmental Cognitive Neuroscience: From Agenda Setting to Hypothesis Testing*** by van den Bos & Eppinger.

***The Audacity of Specificity: Moving Adolescent Developmental Neuroscience Towards More Powerful Scientific Paradigms and Translatable Models*** by Pfeifer & Allen.

***The Importance of Sexual and Romantic Development in Understanding the Developmental Neuroscience of Adolescence*** by Suleiman & Harden.

The primary goal in inviting these commentaries was *not* to criticize or endorse a specific model, but rather to take the opportunity to consider more broadly the merits and limitations of these and other models. The commentators were asked to offer their thoughts—to consider what additions, refinements, new models, and new approaches to clarifying the goals of models might help to advance scientific, clinical, and policy goals by deepening understanding of adolescent development.

In addition, one of the commentaries makes a link to a third review paper in this issue of DCN relevant to these discussions, ***Dopaminergic Reward Sensitivity Can Promote Adolescent Health: A New Perspective on the Mechanism of Ventral Striatum Activation***, by Telzer, so we include a link [here] to that paper as well.

Together, these papers and commentaries provide an impressive range of ideas about models and suggestions as to how best

to refine and extend these to advance the developmental science of adolescence. It is our hope that these papers and commentaries can begin a larger open and productive discussion—one that helps to integrate perspectives. In ways that can help us to work together as part of a young, exciting, and rapidly growing field, to develop new refinements to our models, to develop novel (testable) hypotheses, and to promote new collaborations and teams, and innovative approaches to testing these hypotheses.

Our aims are not only to advance the science and knowledge in exciting ways, but also to serve the long term goals of providing new insights that can help to improve the lives of youth through early intervention, prevention, and informing opportunities for positive development.

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Available online 31 December 2015