

## Preface

One of the challenges faced in today's science of autism spectrum disorders (ASD) is that the amount of information to master and the number of different perspectives to consider increase with the number of scientists engaged in examining autism. This is both a boon and a bane for the field. There are now many more scientists from a wider array of disciplines working to understand autism than ever before. This is illustrated by the growth in the number of scientific articles published on ASD. In the four-plus decades between the discovery of ASD in the early 1940s and December 1989, approximately 4,577 peer-reviewed scientific papers and 495 books were published on ASD. In the last two-plus decades, approximately 39,822 peer-reviewed articles and 5,875 books were published (ProQuest.com/PsycINFO search, September 19, 2015). This recent flood of information has substantially enriched our understanding of the genetic and neurodevelopmental factors that may be involved in ASD, and has improved our methods of early identification, diagnosis, and treatment. However, the wealth of new observations comes at a cost: It is increasingly difficult for researchers to recognize or share a common picture of autism across what is now a vastly multidisciplinary science. Each scientific discipline, and each level of analysis within a discipline, emphasizes concepts, methods, and even language that may or may not be familiar to other groups of scientists. The tendency to adopt discipline-specific concepts and a language speeds progress *within* a discipline, but may impede progress and consensus *across* disciplines.

There is nothing unique about the science of autism in this regard. Science is ultimately a form of human collaboration and communication. From many disparate voices and points of view, valid, commonly held concepts ultimately emerge. In the early years of a science, though, the process can be a bit cacophonous. Such is the case in the science of autism today. The advancing diversity of the research on autism has increased the challenge of reaching a consensus on what, if any, developmental processes are *central* or *essential* to ASD. Some may regard this assertion as a bit hyperbolic. Perhaps, but people are complex. When neurodevelopmental disorders interact with human nature, complexity is multiplied, so a precise description of the essential nature of a disorder is going to be difficult and time-consuming to establish. In this regard, one of two possibilities may best describe the present state of affairs in research on autism. One is that we have yet to develop sufficiently robust theory or research approaches to guide us to the right places to look for the answers to the question of what processes or dimensions are essential to autism. The alternative, though, is that we *have* already begun to look in the right places, but that amidst the daily deluge of new data we have yet to fully appreciate and effectively communicate what we have observed. In my view, this second possibility very much describes our current understanding of the role of the development of joint attention in the human nature of autism.

*Joint attention* refers to the fluid, exquisitely well-honed human ability to adopt a common point of reference with other people. The name for this dimension of behavior comes from the observation that prelinguistic infants learn to share information and experiences with other people by coordinating their visual, auditory, or tactile attention on objects or events with these people. Hence joint attention first involves coordinating attention with other people to the external world. However, a dynamic dance between social-cognitive neurodevelopment and practice with joint attention to external objects in early infancy leads to the emergence of the capacity to socially coordinate attention to internal mental objects in later infancy. This internalized cognitive capacity for joint attention, and adopting a common point of reference, is fundamental to learning language, developing collaborative and cooperative behavior, and advances in social-cognitive development. Moreover, joint attention is also fundamental to our sense of social relatedness and intersubjectivity when it is accompanied by the perception of sharing meaning and experience with another person.

Given this description of joint attention, it may not come as a surprise that differences in joint attention are among the most important characteristics of autism spectrum development yet identified. Indeed, in my mind, no other symptom dimension has more evidence for its centrality to

ASD. Joint attention measures are consistently observed to be important in the early identification and the later diagnosis of preschool children. Because joint attention is pivotal to human learning, language, and social relatedness, targeted preschool interventions lead to improvements in children with ASD. Early joint attention difficulties also appear to be part of a continuous line of developmental disturbance expressed as social-cognitive or theory-of-mind problems in children and adults with ASD.

Since 1979, an uninterrupted line of 500 studies has attested to the importance of joint attention in autism syndrome development (ProQuest.com/PsycINFO search, September 19, 2015). Nevertheless, there is a decided lack of agreement among scientists about the meaning and importance of joint attention phenomena in the study of ASD (e.g., Charman, 2003; Leekam, 2005). Leekam eloquently described the lack of consensus this way:

Ask any clinician to describe the earliest and most significant impairments in autism, and the chances are that they will put joint attention at the top of the list. Ask them to explain why children with autism have this impairment, and they will be less likely to give you a straightforward answer. The truth is that, despite advances in our knowledge of autism over the last twenty to thirty years, we still have contradictory interpretations for one of the most robust and predictive behavioral indicators of autism. (2005, p. 205)

Each of the “contradictory interpretations” of joint attention phenomena in ASD holds more than a grain of truth. However, many researchers assign a rather static role for joint attention in autism spectrum development, and thus the field has not yet fully appreciated the significance of what joint attention research brings to the current and future science of ASD. Understanding joint attention will not completely explain autism, but it is very likely that no explanation of autism will be complete without a definitive understanding of joint attention’s role in its etiology. This volume has been developed to address the need for greater clarity in recognizing the role of joint attention in the human nature of autism spectrum development.

## Framework of the Book

The book has been developed for students of the science of ASD, including researchers, parents, teachers, and professionals, as well as people who directly experience autism syndrome development. Because the readers of this volume may vary in their goals, interests, and expertise, the text

also varies its presentation of old and new information on the science of autism, as well as the technical level of presentation. Though all the chapters are connected, each chapter has been written as an individual essay that may be read on its own or in combination with other chapters. All the chapters have been written with the goal of presenting evidence from developmental, clinical, neurocognitive, and genetic/molecular research for the hypothesis that joint attention is a fundamental dimension of the phenotype and endophenotype of ASD.

The chapters are organized into three general topics. An introduction to joint attention and its role in the diagnosis of autism is provided in Chapters 1, 2, and 3. These chapters comprise the least technical sections of the book and are intended to provide an introduction that is informative for a wide range of readers. The role of joint attention in social development and social learning, and in the difficulties in these areas that define ASD, is described in Chapters 4, 5, and 6. These chapters involve a more technical discussion of social cognition, developmental science, and intervention science. Nevertheless, Chapter 6 is intended for a wide range of readers interested in better understanding treatment and education for children affected by ASD. Finally, the neuroscience and genetics of joint attention in autism are covered in Chapters 7 and 8. These chapters involve what may be the most technical discussions of the book. They are primarily intended to translate the developmental science of joint attention to applications for readers interested in the biological sciences of autism.

Chapter 1 begins with a review of the historical shifts that have occurred in the conceptualization and diagnosis of ASD. This chapter is not so much about joint attention as it is about the difficulty and complexity involved in trying to define any major facet of human nature, including the nature of autism. Chapter 1 discusses the problems with the initial conceptualization of the prototype of autism as a pervasively unresponsive child. It also discusses the observation that the presentation of autism varies significantly across people; this variability or heterogeneity has made it difficult to categorically define the nature of autism, and thus has complicated both the basic and clinical science of autism. This chapter's contention, though, is that we should expect any category of human nature (including the category of ASD) to have fuzzy boundaries, and that this expectation is important to a more veridical understanding of this syndrome. Heterogeneity is not specific to autism; it is a phenomenon associated with all clinical and nonclinical categories applied to people.

Chapter 2 begins the discussion of the book's central topic by describing how the study of joint attention in ASD has informed and begun to change the conceptualization and diagnosis of ASD. In conjunction with the philosophy of the National Institute of Mental Health

Research Domain Criteria, this chapter discusses the benefits of shifting away from research on ASD as a *category of disorder* to examining ASD as *part of human nature*. From this perspective, ASD is defined in terms of a specific outcome of the interaction of individual differences in the development of critical dimensions of human development. This chapter begins the argument that joint attention is best conceived as one of the distinct dimensions of human development involved in ASD, and not one that can be understood or explained by other important and perhaps better-recognized dimensions.

Chapter 3 reviews the impact that joint attention research has had on advancing diagnosis, screening, and risk measurement for ASD. It describes how joint attention measures, nomenclature, and developmental research have been included in the “gold-standard” diagnostic measures for autism that have been developed since 1990. Sections of this chapter are also devoted to how joint attention measures informed and improved early screening instruments for ASD. Finally, insights derived from joint attention studies of infant siblings of children with autism are reviewed, to provide a better understanding of when in infancy differences in joint attention may indicate risk for autism syndrome development.

Chapter 4 advances the discussion of learning and joint attention, especially in connection with the relations between early joint attention development and childhood/adult social-cognitive development. One of the competing hypotheses about why children with autism have difficulty with joint attention is that it reflects their social-cognitive or theory-of-mind deficits. In discussing this idea, this chapter describes in detail a model of the *learning-to* and *learning-from* phases of joint attention development. This model serves as a means of better understanding how in development children learn to manage the self-referenced (interoceptive and proprioceptive) and external (exteroceptive) information-processing demands of joint attention. It also discusses how learning to manage this type of multichannel information processing may be difficult for children with autism. According to this model, this difficulty leads to later problems with the development of social cognition, language, and social learning.

Chapter 5 discusses three other competing hypotheses. Two of these involve the related ideas that joint attention development and its role in autism may be well explained as part of more primary social orienting or face processing. This chapter provides more details to support the assertion that joint attention is a form of information processing that is fundamental to human learning, and that it cannot be explained satisfactorily in terms of either orienting or face processing. The chapter also reviews data suggesting that joint attention develops early in the first 6 months of life and may be no less primary in development than social orienting

or face processing. The chapter goes on to present the idea that a motivation disturbance in ASD may involve early difficulty with joint attention. A new perspective is discussed here that suggests that this disturbance involves a reduced arousal or reward response to the perception of attention to self, rather than the reduced reward value of attending to other people. The third competing hypothesis discussed in this chapter is that difficulty with joint attention is a circumscribed phenomenon of infancy that has limited validity in basic and clinical research with older individuals with ASD. In response to this hypothesis, the chapter discusses how joint attention plays a lifelong role in learning, intersubjectivity, and cooperative engagement with others. Consequently, it will be important to develop new, sensitive measures of joint attention for both children and adults, to provide a clearer understanding of the role of joint attention in ASD throughout the lifespan.

Chapter 6 concludes the discussion of the role of joint attention in learning with a review of experimental treatment research on this topic. This review highlights advances in effective targeted interventions for joint attention development in autism. The development of targeted intervention treatments for joint attention was one of the first types of treatment research funded in 1997 by the National Institutes of Health Collaborative Programs of Excellence in Autism. A lot has been learned since then, the highlights of which are described at some length in this chapter.

Chapter 7 begins with an overview of how far developmental cognitive neuroscience has come in identifying the discrete neural networks involved in joint attention. Numerous neuroimaging and electroencephalographic studies on this topic are described. These range from two studies of the neural substrates of joint attention in 5- and 6-month-old infants, to multiple studies of the cortical correlates of differences in joint attention between children and adults with and without ASD. This chapter explores why there is considerable overlap in the neural network activated by joint attention tasks and those activated by social-cognitive tasks. It also explores the implications of data currently suggesting that the differences in default network and frontoparietal control network activation may be primary to the differences in joint attention that characterize ASD.

Finally, Chapter 8 moves to the frontier of research on the genetic and related molecular mechanisms that may affect joint attention development in human nature, including the human nature of autism. Research on genetic studies of joint attention in ASD, as well as comparative studies of joint attention in primates, are discussed. In addition, the incipient literature on the genetics of social cognition is described. The review of the literature in this chapter leads to potentially important new hypotheses and observations. One is that data across studies converge on the idea

that dopamine-transported genes may interact with oxytocin as well as vasopressin receptor genes in ways that influence joint attention. Moreover, these interactions may reflect repurposing of the actions of these genes in ways that may be different from their repertoire of action in other primates and mammals. These ideas lead to a crucial conclusion of the book: More consideration of the neurodevelopmental and metabolic factors involved in joint attention may be as important to the future study of autism's etiology as joint attention research has been to advances in the clinical assessment and treatment of ASD in the recent past.

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