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CHAPTER THREE

Social Cognition in Individuals With Intellectual and Developmental Disabilities: Recent Advances and Trends in Research

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Abstract

This chapter provides an overview of recent research on social cognition and social functioning in people with intellectual and developmental disabilities (IDDs), with a particular focus on neurodevelopmental disorders associated with distinctive social-cognitive and behavioral phenotypes. We review the main experimental paradigms that have been used to probe social cognition in both typically and atypically developing populations and discuss findings primarily from research on two neurodevelopmental disorders that have been extensively studied in the last 3 decades: Autism spectrum disorders (ASD) and William's syndrome (WS). Viewed in the past as diametric opposites in their social phenotypes, the two disorders have been intensely researched for their potential to provide insights into the neurocognitive bases of sociocognitive capacities and ultimately into the neurogenetic underpinnings of the "social mind." The findings reviewed in this chapter convey a mixed and sometimes contradictory account of commonalities and differences in sociocognitive abilities between and within syndrome, underscoring the need to further explore, within an etiology-based framework, individual differences, developmental trajectories, links with genetic variation, and experiential factors to solve the many puzzles of social cognition in people with IDD.

1. INTRODUCTION—SOCIAL COGNITION AND SOCIAL FUNCTIONING: DEFINITIONS AND CONCEPTUAL DISTINCTIONS

Over the past 3 decades, there has been a tremendous surge of interest in social cognition and in its neurocognitive and neurogenetic underpinnings. This interest, spanning disciplines from primatology to philosophy, culminated in the emergence of the interdisciplinary research field of social-cognitive neuroscience (Lieberman, 2007; Ochsner, 2004). Efforts aimed at understanding the "social mind" and the "social brain" in typical development have been complemented by investigations of individuals with intellectual disabilities and developmental disorders (ID&DDs), in particular those of known etiology (Hodapp & Burack, 1990). Research on IDDs gained renewed relevance in the context of these interdisciplinary efforts for both theoretical and practical reasons: from a theoretical standpoint, it provides opportunities for advancing our understanding of typical development by examining how different profiles of sociocognitive strengths and weaknesses may emerge from altered neurobiology, genetics, and other experience-related constrains on developmental processes; from an applied perspective, such research could guide the design and development of targeted interventions and educational strategies aimed at improving

the lives of people with ID&DDs, who often have difficulties navigating the social world, which may have long-range negative consequence for their adaptive functioning and general well-being (Dykens & Hodapp, 1997).

This chapter provides a selective review of recent findings from social cognition research in the field of IDDs, in particular from research on neurogenetic disorders. The research reviewed focuses on the processes of understanding the social world, or the receptive sociocognitive abilities of people with ID&DDs, which are foundational for the production and regulation of social behavior. The theoretical and applied significance of the findings reviewed will be discussed in light of advances in social-cognitive neuroscience.

Although there is no universally accepted definition of the construct "social cognition" in the literature (Cook & Oliver, 2011), scientists share the implicit assumption that it refers to "the processes by which people understand themselves and other people" (Beer & Ochsner, 2006, p. 98). While some researchers restrict the scope of the term "social cognition" to processes involving cognitive inferences about mental states (e.g., sociocognitive theory of mind) and to various forms of social reasoning (Tager-Flusberg & Sullivan, 2000), for the purposes of this chapter, we use the term in a broader sense, as a construct encompassing the various abilities and processes (some automatic, others controlled) involved in making sense of people and acting in the social world. Although any theoretical divisions of the construct are ultimately conventional, here we distinguish component processes based on the increasing complexity of the information processing demands involved. In this framework, social perception is the starting point of processing social information; it comprises processes that involve direct, automatic registration and interpretation of social signals, (e.g., face and voice identity processing, emotion processing, impression formation, and social appraisal). Inferential processes are often involved in the perception of social cues, such as in interpreting the meaning of a facial or vocal expression (e.g., What is the emotion conveyed by this expression? Is this face familiar? etc.) but social perceptual processes operate on information directly available in the stimulus, in contrast to inferring "unseen" mental states to explain behavior. The next level involves making inferences about people's behavior by relating observable actions to underlying mental states, and implies the aspects of social cognition referred to as theory of mind (ToM), including social perspective taking and empathy, social attributions, and other forms of social reasoning (e.g., moral judgments).

Social functioning reflects how appropriate and successful is a person's behavior in social interactions and engagements with others, from carrying out a conversation to forming and maintaining interpersonal relationships. To date, most assessments of social functioning used in research have been primarily based on caregiver or teacher report, either administered in an interview format or consisting of various questionnaires and rating scales of daily behaviors. Many studies have relied on information provided by the Vineland Scales of Adaptive Behavior (VABS, Sparrow, Balla, & Cicchetti, 1984, 2005) to estimate the quality of social functioning, relative to typical age expectations, in people with IDD. The links between social cognition and social functioning are not direct or unmediated, and a substantial amount of empirical research has been dedicated to analyzing the complexities of these relations in both typically and atypically developing populations (Hughes & Leekam, 2004).

In this chapter, we present the main experimental approaches that have been used in behavioral research to probe different components and levels of social cognition in individuals with IDD, following the hierarchical organization of sociocognitive processes describe above.

2. SOCIAL COGNITION AND SOCIAL FUNCTIONING IN INDIVIDUALS WITH IDD

If in the past the characterization of people with IDD was primarily based on their intellectual functioning or IQ, more recently the emphasis in defining IDD has shifted toward "adaptive functioning," which encompasses aspects of communication, social skills, and skills to live independently (American Psychiatric Association, 2013; Schalock et al., 2010). An important aspect of adaptive functioning is the ability to navigate the social world. A majority of people with IDD—whether associated with specific neurodevelopmental disorders or of unknown etiology—encounter social difficulties in the real world, and usually perform below age (and some below mental age) expectations on many behavioral tests of social cognition (Leffert & Siperstein, 2002). However, the extent to which such difficulties are dependent on cognitive impairments may vary widely among individuals as a function of the etiology of IDD.

Two general theoretical questions arise in the study of social cognition in IDD. One pertains to etiological specificity—are impairments or strengths in particular aspects of social cognition or in their developmental course disorder specific? The other pertains to development—are the deficits in social

cognition found across many populations with IDD an expression of delay or a plateau along an otherwise typical trajectory of skill emergence or is the development of social cognition following atypical trajectories with some skills emerging in different temporal sequences from the "normal course" and others never emerging? Answers to these questions may have important implications for clinical and educational decisions and for designing interventions tailored to particular populations with IDD, targeting specific skill developments within appropriate time windows (Reilly, 2012).

Research and clinical practice have uncovered a wide heterogeneity of cognitive and behavioral profiles among individuals with IDD, which precludes a meaningful characterization of this population as a unitary group, in terms of their social cognition and social functioning (Pegoraro, Steiner, Celeri, Banzato, & Dalgalarrondo, 2014). While in the 1980s and 1990s, research in the field of IDD involved primarily mixed groups of people with heterogeneous causes of cognitive disability, more recently an etiology-based approach has become the prevalent research practice in the field (Dykens & Hodapp, 2001; Hodapp & Dykens, 2001). With advances in diagnostic procedures, including the wide-spread availability of genetic testing, it is increasingly possible to identify individuals with IDD as cases of people with neurodevelopmental disorders, some with known genetic etiology, others of complex and not yet fully understood etiology, such as autism spectrum disorders (ASD). Over the last decades, research has made significant progress in refining the phenotypic descriptions of many neurodevelopmental disorders, including those of rare incidence (Hodapp, 2004). This work has led to the realization that distinctive profiles of social traits, abilities, or deficits are frequently associated with different syndromes that have a genetic origin (Di Nuovo & Buono, 2011; Dykens, 1995; Dykens & Hodapp, 2001). From the standpoint of social-cognitive neuroscience, the association of distinctive social–behavioral phenotypes and IDD with syndromes caused by known genetic abnormalities provides exciting opportunities to examine genotype–phenotype relations and may contribute to understanding the neurobiological underpinnings of social and cognitive functions (Järvinen, Korenberg, & Bellugi, 2013; Reiss et al., 2004).

2.1 Etiology-Based Approaches to Research on Individuals With IDD

Interest in neurogenetic disorders has grown exponentially in the last decades, fueled by unprecedented advances in genetics, in neurobiology, and in understanding neurodevelopment in typical and atypical populations,

along with increasingly refined characterizations of the social–behavioral phenotypes associated with particular syndromes. For instance, over the last decade, social phenotypic findings have been accumulating for ASD, attention-deficit hyperactivity disorder (ADHS), fragile X syndrome (FXS), Down syndrome (DS), William's syndrome (WS), Prader–Willi syndrome (PWS), Angelman syndrome, Smith–Magenis syndrome, Turner syndrome, Klinefelter syndrome, and velocardiofacial syndrome (Bora & Pantelis, 2016; d'Arc & Mottron, 2012; Rosner, Hodapp, Fidler, Sagun, & Dykens, 2004; Wishart, Cebula, Willis, & Pitcairn, 2007; see Feinstein & Singh, 2007 for review). Many of these developmental disorders present with various forms of deficits in social cognition and communication. Comorbidity with autistic symptoms has also been reported across several disorders (Howlin, Wing, & Gould, 1995; Klein-Tasman, Phillips, Lord, Mervis, & Gallo, 2009; Veltman, Craig, & Bolton, 2005) most prominently in FXS (Budimirovic & Kaufmann, 2011). However, syndromes may vary dramatically in other aspects of social behavior and social functioning, such as motivation for social engagement and interest in social interaction, despite commonalities in social-cognitive deficits. A case in point is illustrated by the comparison of ASD and WS, two complex neurodevelopmental disorders that present strikingly contrasting overt features of their social–behavioral phenotypes, but with similar impairments in several aspects of social-cognitive and communicative abilities. Recent findings from research on these two neurodevelopmental disorders will be used to illustrate the complex relations among social behavior, social cognition, and social-adaptive functioning in people with IDD, and possible changes in these relations across development.

2.2 Neurodevelopmental Disorders With Distinctive Social-Cognitive Phenotypes: ASD and WS

Both ASD and WS are neurodevelopmental disorders in which particular aspects of social functioning, not directly related to intellectual impairments, are considered core symptoms of the syndrome. The two disorders have been often described as representing opposite ends of the sociability continuum (Deutsch, Rosse, & Schwartz, 2007; Doyle, Bellugi, Korenberg, & Graham, 2004; Jones et al., 2000). Portrayals of the two syndromes, especially in the popular media, still suggest that people with ASD are aloof, lacking empathy, unable and unwilling to engage in social interactions (Brewer & Murphy, 2016; Draaisma, 2009), whereas people with WS are socially savvy, engaging, emotionally attuned to others, therefore experts

in navigating the social world. In contrast to these descriptions, accumulating evidence from empirical research using methodologically sound designs rendered a much more complex picture, documenting a mixture of social abilities and disabilities in both syndromes, as well as variation in phenotypic aspects over development. A selective review of this evidence will be presented in the next sections of the chapter.

According to the fifth edition of the diagnostic and statistical manual of mental disorders (DSM-5; American Psychiatric Association, 2013) two core domains of impairment define ASD: (1) social communication and social interaction and (2) restricted, repetitive patterns of behavior, interests, or activities. Specific criteria for the social communication and social interaction domain include deficits in social–emotional reciprocity, impaired nonverbal communicative behaviors and difficulties in developing relationships. These symptoms must be present from early childhood and cause impairments in everyday functioning. From the first descriptions of the condition by Kanner in 1943, autism has been viewed primarily as a social dysfunction disorder. Although intellectual disability (ID) and autism covary at very high rates (Matson & Shoemaker, 2009) ID is not a core feature of the syndrome and much of the research on social cognition in ASD has been conducted with "high-functioning" individuals with ASD, who typically have normal language or general cognitive abilities (e.g., are defined in many studies as having an IQ score over 70).

While there is wide agreement that social dysfunction is at the core of the syndrome's manifestations, findings related to *specific* aspects of social-cognitive deficits in ASD vary across studies even when similar or identical methodologies have been used, and the research literature is chockfull of conflicting results pertaining to how people with ASD process social information (Pelphrey, Shultz, Hudac, & Vander Wyk, 2011; Scheeren, de Rosnay, Koot, & Begeer, 2013; Yi et al., 2013). The puzzle of inconsistent findings in almost every domain of social cognition in ASD has prompted researchers to conduct a number of metaanalyses of studies targeting such abilities, which will be guiding our discussion of this research (Papagiannopoulou, Chitty, Hermens, Hickie, & Lagopoulos, 2014; Tanaka & Sung, 2016; Uljarevic & Hamilton, 2013; Weigelt, Koldewyn, & Kanwisher, 2012; Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998).

WS is a relatively rare disorder with an estimated prevalence of 1 in 7500–10,000 live births (Stromme, Bjornstad, & Ramstad, 2002). This neurodevelopmental disorder received a great deal of attention from cognitive

developmental scientists in the last 20 years because it appeared to afford an opportunity to investigate the relations between a well-defined genetic abnormality and a unique cognitive and social phenotype (Bellugi & St. George, 2000; Bellugi, Wang, & Jernigan, 1994; Jarvinen-Pasley & Bellugi, 2013). The genetic cause of WS is a hemizygous contiguous deletion of about 28 genes in the chromosomal region 7q11.23 (Hillier et al., 2003). Individuals with WS generally have ID in the mild-to-moderate range, with mean full scale IQ between 50 and 60, although there is wide variability in intellectual functioning within the population, ranging from severe ID to average intelligence (IQ scores <40 to >100). The neurocognitive profile of WS in its mature form has been described as consisting of markedly uneven abilities, such as relatively good face recognition, expressive language, and short-term memory and severe deficits in visual–spatial–construction skills (Mervis et al., 2000).

The social–behavioral profile of WS in both children and adults has been described as "hypersocial," characterized by an exaggerated affiliative drive: people with WS are unusually friendly, affectionate, gregarious, driven to interact with others, including strangers; they seem sensitive to people's emotions, are highly empathic, and are relatively skilled at using expressive language to keep their audience engaged (Doyle et al., 2004; Jarvinen-Pasley et al., 2008; Jones et al., 2000; Klein-Tasman, Li-Barber, & Magargee, 2011; Reilly, Klima, & Bellugi, 1990; Tager-Flusberg & Plesa Skwerer, 2006). Many of these characteristics appear to be clear social assets. Nevertheless, by the time they enter middle school children with WS find it hard to become part of the network of peer relations that define the social lives of older children. Individuals with WS experience difficulties in social functioning, especially in forming and maintaining friendships and other meaningful social relationships over time. A significant proportion of adolescents and adults develop high levels of anxiety and social isolation (Davies, Udwin, & Howlin, 1998; Einfeld, Tonge, & Rees, 2001; Elison, Stinton, & Howlin, 2010; Howlin & Udwin, 2006) despite their drive toward social connections. The fascinating puzzle about WS is understands why such high propensity for social engagement results in such poor social outcomes.

3. COMPONENTS AND LEVELS OF SOCIAL-COGNITIVE CAPACITIES

There is an abundance of behavioral research on almost every aspect of social cognition in ASD, starting with perception of human faces or voices to

the examination of higher-order social reasoning and moral judgments. Many of the same experimental paradigms have been used in research with individuals with WS and with other developmental disorders, some of which have been included as comparison groups in studies focused on ASD or WS (e.g., DS, FXS, and PWS), because of their particular social–behavioral phenotypes or the possibility of matching groups on both chronological age and IQ (verbal or nonverbal mental age).

3.1 Social Perception

Social perception refers to registering and processing the informational cues directly available in the social environment, such as information provided by human faces and voices. It is the starting point for further interpretation of this information, which may entail inferring emotional and mental states from facial, body, gesture, or vocal expressions. Because social perceptual abilities are critical for everyday interpersonal interactions, a great deal of research has been devoted to their assessment, and to understanding their functioning in typical individuals and in people with IDD.

3.1.1 Face and Voice Identity Processing

Human faces are among the most salient stimuli in our environment and it is not surprising that for typical individuals face processing seems to be automatic and effortless. Face processing, at least in typical adults, is considered a "special perceptual process" (relative to the perception of other types of visual stimuli), subserved by a distinct neural system (Haxby, Hoffman, & Gobbini, 2002; Kanwisher, McDermott, & Chun, 1997), which includes a specialized area of the occipitotemporal cortex known as the fusiform face area (FFA). This area has also been related to highly developed expertise in other categories of stimuli (Gauthier & Nelson, 2001; Gauthier, Skudlarski, Gore, & Anderson, 2000), although this view is not shared by all researchers (Kanwisher & Yovel, 2006). Most humans are experts in processing faces and show increased FFA activation when doing so, compared to visually processing objects.

A hallmark of expertise in processing faces in the use of holistic and configural perceptual strategies in face identification, meaning processing the combination of facial features as an integrated perceptual whole or Gestalt and processing the spacing between facial features, respectively, when viewing upright faces, instead of prioritizing individual features, as people do with object recognition (Maurer, Le Grand, & Mondloch, 2002; Mondloch, Le Grand, & Maurer, 2002; Tanaka & Farah, 1993).

Studies of adults and children with ASD have generally indicated that many, although not all, individuals with ASD show impaired face processing ability (Dawson, Webb, & McPartland, 2005; Weigelt et al., 2012) across different experimental paradigms, including behavioral testing of face identity recognition and memory for both familiar and unfamiliar faces (for review, see Tanaka & Sung, 2016). Moreover, findings of disrupted face processing in ASD have been reported in studies using electrophysiology recordings (e.g., McPartland, Dawson, Webb, Panagiotides, & Carver, 2004; O'Connor, Hamm, & Kirk, 2005; Webb et al., 2012) or functional MRI paradigms (e.g., Kleinhans et al., 2008; Pierce, Muller, Ambrose, Allen, & Courchesne, 2001; Schultz et al., 2000). Interpretations of the face processing impairments reported for both children and adults with ASD, and the proposed explanations for such deficits vary substantially across studies. One explanations for the behavioral results suggests that people with ASD use atypical perceptual styles when viewing faces, relying more on featural rather than holistic and configural processing, a style closer to how TD individuals process objects (Lahaie et al., 2006; Langdell, 1978). Representative tasks used to probe holistic and configural face processing are the face inversion task, the whole-part task, and the composite face task (Rossion, 2009; Tanaka & Farah, 1993; for review, see Weigelt et al., 2012). Specifically, performance in TD individuals is significantly diminished when presented with upside down faces (Valentine, 1988), or when face parts (eyes and mouth) are presented in isolation instead of integrated in a whole face (Tanaka & Farah, 1993), or when the stimulus is composed from the top half of one face and the bottom half of a different face (Young, Hellawell, & Hay, 2013), because such experimental manipulations disrupt the holistic and configural processing of the face Gestalt. Several behavioral studies have reported that individuals with ASD are not affected to the same degree as TD controls by inversion effects (Hobson, Ouston, & Lee, 1988; Langdell, 1978; Rose et al., 2007), while others found a reliable inversion effect in children and adults with ASD (Falck-Ytter, 2008; Hedley, Brewer, & Young, 2015; Lahaie et al., 2006; Scherf, Luna, Kimchi, Minshew, & Behrmann, 2008). Similar contrasting findings have been reported for many tasks that probe holistic and configural perceptual processes in face identity recognition in individuals with ASD (Jemel, Mottron, & Dawson, 2006; Tanaka & Sung, 2016; Weigelt et al., 2012). In a recent metaanalysis of face processing studies, Tanaka and Sung (2016) reviewed the prevalent accounts proposed to explain the face recognition difficulties showed by many individuals with ASD evaluating the

empirical evidence for each claim, and discussed possible reasons for the contradictory findings reported across studies. Two hypotheses link the face recognition difficulties found in individuals with ASD to atypical/immature perceptual processing styles: these accounts propose a lack of holistic processing in face perception (Teunisse & de Gelder, 2003) or a local processing bias (Happé & Frith, 2006) that interferes with global processing strategies necessary for successful face recognition. The comprehensive analysis of results from numerous studies using the same tasks relevant to each of these hypotheses, indicated that adolescents and adults with ASD used typical processing strategies in face recognition, however they failed to rely on and process appropriately information from the most salient part of the face, the eye region (Caldara et al., 2005; Ristic et al., 2005; Rutherford, Clements, & Sekuler, 2007).

The "eye avoidance" hypothesis endorsed by these authors appears to be corroborated by increasingly sophisticated studies using eye-tracking technology and by psychophysiological measures that show increased arousal in people with ASD when looking at eyes (Dalton et al., 2005; Hirstein, Iversen, & Ramachandran, 2001; Joseph, Ehrman, McNally, & Keehn, 2008; Kylliainen & Hietanen, 2006). One intriguing finding, which was reported in several studies using eye-tracking methods, indicated that individuals with ASD attended preferentially to the mouth region when passively viewing faces (Dalton et al., 2005; Spezio, Adolphs, Hurley, & Piven, 2007), as well as when watching actors interacting in emotionally charged scenes, spending significantly less time looking at the actors' eyes compared to typical adults (Klin, Jones, Schultz, & Volkmar, 2003). Moreover, Jones, Carr, and Klin (2008) reported that the mouth bias was seen in 2-year-old children with ASD who showed a significant decrease in looking time at the eyes but increase in looking time at the mouth compared to both TD and developmentally delayed children when watching video clips of an actress looking directly into the camera, trying to engage the viewer by playing pat-a-cake, peek-a-boo, etc. For the toddlers with ASD lower levels of eye fixation predicted greater social disability, an association that, according to the authors, could represent a potential biomarker for quantifying syndrome manifestation at an early age, which is important for planning early interventions. Other studies however did not find a mouth bias in viewing faces, showing that individuals with ASD spent comparable amounts of time looking at the mouth as did controls, but that they did spend less time looking at the eyes, in favor of looking at other, less relevant, parts of the face (Pelphrey et al., 2002; Rutherford et al., 2007).

Studies using fMRI paradigms have indicated that individuals with ASD showed lower activation in the FFA compared to matched controls in face perception tasks, such as during face and object discrimination tasks (Schultz et al., 2000), gender discrimination tasks (Hubl et al., 2003), or face familiarity tasks (Dalton et al., 2005). However, other studies have shown normal activation of the FFA in response to faces in ASD under different task conditions, such as passive viewing (Hadjikhani et al., 2004), or gender discrimination of familiar and unfamiliar faces (Pierce, Haist, Sedaghat, & Courchesne, 2004). In a comprehensive analysis of the empirical evidence provided by a number of face processing paradigms, including behavioral, electrophysiological, and functional imaging data. Jemel et al. (2006) concluded that under certain conditions individuals with ASD do not differ from TD persons in their performance and brain activation related to processing faces, although the default processing style of faces in ASD is more oriented toward their local aspects. "Typical" face perception performance and FFA activation have been found especially when the task instructions or characteristics (e.g., presence of a fixation cross) directed the participant's attention toward the eye region of faces, suggesting that deficits in face recognition may be related to atypical *spontaneous* allocation of attention (e.g., away from the eyes). Over time an "eye avoidance" strategy "has cascading effects on the ability to encode and discriminate information and facial identity, expression and intention and further interferes with social processing" (Tanaka & Sung, 2016, p. 15).

To trace the developmental origins and course of face processing atypicalities in ASD researchers enrolled increasingly younger children with ASD or at risk for ASD (e.g., younger siblings of children diagnosed with ASD, who have an increased genetic risk to develop ASD) in studies that did not require explicit behavioral responses. Several studies probed face processing in young children with ASD and age-matched TD children, by analyzing their neural responses (event-related potentials—ERPs) to viewing familiar and unfamiliar faces (Dawson et al., 2002; Webb, Dawson, Bernier, & Panagiotides, 2006). Findings indicated that 3–4-year-old children with ASD showed differences in their ERP responses to face familiarity, as well as slower neural responses to faces in general when compared to age-matched TD children, raising the question of whether the brain response differences reflected atypical development of face processing in ASD or developmental delay. Webb et al. (2011) examined this question by showing pictures of familiar and unfamiliar faces to toddlers with ASD and to 12–30-month-old TD children while electrophysiological measures

of neural response (ERPs) were collected. In addition, these researchers used a parent-report measure to assess children's level of socialization relative to the emergence of common social behaviors in typical development—the Socialization Subscale of the Vineland Adaptive Behavior Scales (VABS, Sparrow et al., 2005) that yields, among other estimates, age-equivalent scores. Results indicated that the pattern of neural response of the 18–30-month-olds with ASD was largely similar to that shown by 12–17-month-old TD infants who had similar developmental levels of socialization. Moreover, for both groups developmental changes in neural responses to faces were related to estimates of adaptive social behavior (e.g., socialization age-equivalent scores on the VABS). These findings are consistent with an "experience-expectant" account of face processing (Nelson, 2001), which explains the development of the face processing system as a progressive specialization based on the interaction of preexisting neural structures with experiences typically available to all individuals. In this view, the development of face processing may be disrupted or delayed for children with ASD possibly because these children exhibit fewer of the typical social behaviors that are likely to provide "expected" experiences (e.g., Dawson et al., 2005; Grelotti, Gauthier, & Schultz, 2002; Webb et al., 2011). Indeed studies of infants at risk for ASD (who have an older sibling with ASD) have generally found that until about 6 months there were no differences on a variety of measures (Ozonoff et al., 2010), including face processing, between the infants who later on were diagnosed with autism and the TD infants, suggesting that disruptions in face processing (e.g., delay in the specialization on the brain system involved in face processing) may emerge over development. Although the hypothesis of reduced experience with faces and especially with the most salient aspects of faces, the eyes, appears to explain many aspects of the difficulties shown by people with ASD with face processing, to date there is no unanimous agreement among scientists with respect to its relevance for understanding the origins of atypical social perceptual processes in ASD.

In contrast to the "eye avoidance" tendency shown by individuals with ASD, people with WS are fascinated by faces from an early age (Mervis et al., 2003) and it is not surprising that face recognition appears to be strength in WS. Usually individuals with WS perform at age expectation levels on standardized tests of facial recognition or memory for faces (e.g., the Benton Facial Recognition Test, Benton, Hamsher, Varney, & Spreen, 1983; the Rivermead Behavioral Memory Test, Wilson, Cockburn, & Baddeley, 1985). Anecdotal reports of children with WS recognizing people they

had not seen in many years are common among their parents. There is a lively debate, however, in the literature about the processes underlying the relatively good performance of individuals with WS in face recognition: some researchers suggest that individuals with WS use typical perceptual strategies (e.g., holistic processing) for face recognition, showing the face inversion effect (Isaac & Lincoln, 2011), while other researchers claim that people with WS use primarily a piecemeal strategy (more similar to that of individuals with ASD) in recognizing faces (Dimitriou, Leonard, Karmiloff-Smith, Johnson, & Thomas, 2015). Holistic face processing for upright faces has been demonstrated for both adults (Tager-Flusberg, Plesa Skwerer, Faja, & Joseph, 2003) and toddlers with WS (Cashon, Ha, DeNicola, & Mervis, 2013). The development of face processing expertise continues throughout childhood in typical children, and one of the later skills to emerge is the ability to use configural relations (e.g., relative distances between internal face features) in face recognition (Mondloch, Geldart, Maurer, & Le Grand, 2003). In a series of experiments probing identity recognition and difference detection when configural changes were manipulated, Karmiloff-Smith et al. (2004) showed that, compared to age-matched controls, individuals with WS were less sensitive than the controls to configural information, despite their good performance on the standardized test of face recognition. Because the WS participants showed a configural-processing deficit both with respect to their chronological age and to their level of performance on the Benton Facial Recognition test, the authors concluded that there is both delay and deviance in the development of face processing expertise in WS relative to the typical trajectory. These authors suggested that WS represents a case illustrating how similar apparently normative outcomes are the result of different developmental processes.

Some evidence from electrophysiological recordings used to examine brain responses to faces in adults with WS partly supports this hypothesis. Mills et al. (2000) compared adults with WS with age- and gender-matched controls on both early (indexing attention to faces) and late (indexing recognition of faces) ERP components during a face identity match paradigm that required the participants to judge whether two faces were the same or different. The WS participants showed unusually small early ERP components but large N200 peaks reflecting increased attention, while on the later N320 component, which is linked to face recognition processes, the ERP patterns found among the adults with WS were similar to those seen in younger controls, but were somewhat larger and delayed relative to the

age-matched adults, suggesting developmental delay rather than atypical processing at the level of neural responses to faces in people with WS (see also Grice et al., 2001).

Both anecdotal/parental reports and laboratory controlled observational paradigms indicate that individuals with WS of all ages spend more time looking at faces than their peers do in real life, and often their look is quite intense (Mervis et al., 2003). Several experimental eye-tracking studies suggested that people with WS spent more time looking at the eye region than at other features of faces when viewing static or dynamic faces or scenes (Riby & Hancock, 2008, 2009a, 2009b; Porter, Shaw, & Marsh, 2010). This perceptual strategy may help individuals with WS in face recognition because the eye region is the most salient part of the face, conveying a wealth of information not just about identity but, more importantly, about intentions (e.g., direction of gaze) and possibly other mental states. Although this finding seemed to hold up across several experimental paradigms, including passive viewing, visual search tasks, and detection of gaze-direction tasks, recent investigations showed that this eyes-bias may not be universal in WS and that significant within group heterogeneity is found in visual behavior. For instance, some participants with WS spent less time on the highly informative region of the eyes when asked to identify mental states from static and dynamic stimuli—by performing a forced-choice judgment between labels provided verbally (Hanley, Riby, Caswell, Rooney, & Back, 2013), and it is possible that their performance on the task reflected this heterogeneity in deployment of visual attention. It is also possible that time spent looking at the eyes is not directly related to understanding more complex information conveyed by this region of the face (e.g., emotions and mental states) beyond identity (Plesa Skwerer, Verbalis, Schofield, Faja, & Tager-Flusberg, 2006).

Less research has been conducted on voice recognition in people with ASD or with WS, although voices can carry important information about the speakers, including identity, gender, emotional, state, and age, information likely to be relevant in the context of social interactions.

While anecdotal reports about people with WS have suggested that they may have good in voice recognition abilities, given the good auditory memory, and the interest in music demonstrated by many individuals with WS, experimental evidence about their accuracy is not yet available, although studies focused on speech prosody and affect recognition in voices have been conducted (Pinheiro et al., 2011; Plesa Skwerer, Faja, Schofield, Verbalis, & Tager-Flusberg, 2006; Setter, Stojanovik, Van Ewijk, & Moreland, 2007).

As with face processing, findings regarding voice processing in ASD have been mixed. Some researchers found that high-functioning individuals with ASD showed difficulties in discriminating and learning unfamiliar voices and in discriminating vocal pitch compared to age-matched TD individuals, although they were not impaired in recognizing famous voices (Schelinski, Roswandowitz, & von Kriegstein, 2017). Other researchers reported no differences in performance in recognizing and memorizing vocal identity between individuals with ASD and TD controls (Lin et al., 2015). However, these researchers claimed that individuals with ASD categorized voices quantitatively based on the exact acoustic features, while neurotypical individuals categorized voices qualitatively based on the acoustic patterns correlated to the speakers' physical and mental properties, suggesting another case where similar outcomes are arrived at by different processing mechanisms. Boucher, Lewis, and Collis (1998) reported that children with ASD were not impaired relative to controls on familiar voice–face matching, on familiar voice recognition and on unfamiliar voice discrimination. More research is needed to better understand if the auditory perceptual abilities of people with ASD differ from those of TD controls with respect to processing social auditory signals and if processing of voices under experimental conditions is similar to the auditory processing styles used in real life by individuals with ASD or WS.

3.1.2 Emotion Processing

Many studies probing experimentally the ability of people with IDD to recognize emotions have reported difficulties in this population when compared to groups of TD individuals matched on chronological age and even matched on mental age (McAlpine, Kendall, & Singh, 1991; Owen, Browning, & Jones, 2001; Rojahn, Kroeger, & McElwain, 1995; see Scotland, Cossar, & McKenzie, 2015 for review). However, it remains debated whether people with IDD of unknown etiology show specific emotion–perception deficits or whether such deficits are a consequence of cognitive difficulties with other information processing demands of the tasks administered (Moore, 2001).

Rojahn, Rabold, and Schneider (1995) proposed the "emotion specificity" hypothesis, arguing that the impaired performance on emotion recognition tasks shown by people with IDD is directly linked to specific impairments in *emotion–perception* abilities and it cannot be fully explained by cognitive-intellectual deficits alone. In contrast to this view Moore (2001), after reviewing the evidence for the specificity of emotion

recognition deficits, proposed that the poor performance on a variety of tasks may be due to IQ-related information processing deficits, such as memory, attention, imagination, or dealing with static or ambiguous stimuli.

Recently, Scotland, McKenzie, Cossar, Murray, and Michie (2016) investigated the impact of task paradigm, stimulus type, and preferred processing style (global/local) on accuracy of emotion recognition in people with IDD. Although they found that, to some extent, the task paradigm and stimulus type may have an effect on performance in adults with IDD, the only predictor of emotion recognition ability after controlling for estimated cognitive ability was processing style (local perceptual style facilitates decoding emotional cues). They concluded that processing style is related to emotion recognition independently of having ID.

With respect to children and adults with ASD findings are mixed and even contradictory across studies (for review, see Harms, Martin, & Wallace, 2010; Nuske, Vivanti, & Dissanayake, 2013; Uljarevic & Hamilton, 2013). Research on emotion recognition in ASD has been focused primarily on the visual modality, on processing emotional expression in faces, with the participant usually being tested on a selection from the six "basic" emotions of happiness, sadness, fear, anger, surprise, and disgust, portrayed in various forms of face emotion stimuli: static images or photographs (e.g., the Ekman faces: Ekman & Friesen, 1976); video clips where actors demonstrate particular emotions, or computer-generated images of faces that can be closely controlled on relevant parameters, such as the degree of intensity of the emotion or the face configuration, etc. (Evers, Kerkhof, Steyaert, Noens, & Wagemans, 2014; Gross, 2004; Joseph et al., 2005).

Some studies reported that children and adults with ASD, even those without ID, showed impaired performance in the recognition of basic emotions, especially negative emotions (Ashwin, Chapman, Colle, & Baron-Cohen, 2006; Boraston, Blakemore, Chilvers, & Skuse, 2007; Pelphrey et al., 2002; Wallace, Coleman, & Bailey, 2008). Other studies, however, found no differences in accuracy of basic emotion recognition between participants with ASD and control groups of TD children and adults matched on age and IQ (e.g., Castelli, 2005; Grossman, Klin, Carter, & Volkmar, 2000; Hefter, Manoach, & Barton, 2005; Ozonoff, Pennington, & Rogers, 1990; Tracy, Robins, Schriber, & Solomon, 2011). Rump, Giovannelli, Minshew, and Strauss (2009) suggested that some of the inconsistencies in the literature may be clarified by taking a developmental approach to the study of emotion recognition in individuals with ASD.

These authors pointed out that most studies of children with ASD younger than 10 years reported impairments in recognizing and labeling prototypical emotional expressions when compared to TD controls, whereas studies involving individuals with ASD over 12 years old, including adults, usually report no such differences. Although recent studies usually show that deficits are not found on tasks probing recognition of simple "full blown" emotions (e.g., happy, sad, angry, and fearful), when the tasks involve subtler emotional expressions of "lower intensity," or more complex social emotions such as embarrassment, pride, surprise, etc., or if expressions are displayed for a brief duration (Gepner, de Gelder, & de Schonen, 2007; Greimel et al., 2014; Humphreys, Minshew, Leonard, & Behrmann, 2007; Piggot et al., 2004) individuals with ASD tend to show lower levels of accuracy compared to controls. In it worth keeping in mind that to date the vast majority of the studies on emotion processing in ASD have included high-functioning individuals, who may rely on compensatory strategies and verbal mediation to succeed in explicit tasks of emotion recognition (Grossman et al., 2000), but may have difficulties decoding emotional signals in the rapid, dynamic flow of real-life social interactions.

Emotion processing difficulties in ASD have been related to atypical allocation of attention (e.g., reduced attention to the eye region of faces, which is informative especially for distinguishing between different negative emotions), face processing abnormalities (e.g., deficient configural ability since changes in the configuration of the face play an important part in conveying affective expressions), atypicalities in social reward mechanisms (e.g., nonsocial activities may be more rewarding than social ones, diminishing opportunities to learn about emotional expressions), and even atypical physiological reactivity to emotional social stimuli (Bal et al., 2010; Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012; Joseph et al., 2005; Kuchinke, Schneider, Kotz, & Jacobs, 2011). Heterogeneity in emotion processing across participants with ASD has been noted in almost every study, although, until recently, results have usually been reported mostly in terms of group differences.

People with WS have been often described as very responsive to the emotional states of others, yet on *explicit* measures of emotion recognition administered in various experimental settings children and adults with WS performed no better than comparison groups matched on mental age. This finding was consistent for children, adolescents, and adults with WS across several behavioral tasks that probed the ability to discriminate and to match facial expressions of emotion to other faces expressing the same

emotion (Meyer-Lindenberg et al., 2005; Porter, Coltheart, & Langdon, 2007; Tager-Flusberg & Sullivan, 2000), or to a spoken emotion word (Hanley et al., 2013), or the ability to choose a verbal label corresponding to a facial emotion displayed using static images or dynamic face stimuli (Gagliardi et al., 2003; Plesa Skwerer et al., 2006). Several researchers probed the ability of individuals with WS to label basic emotions expressed in facial and vocal stimuli, using *the Diagnostic Analysis of Nonverbal Accuracy Scale* (DANVA-2; Nowicki & Duke, 1994). This is a standardized measure of emotion recognition that comprises two subtests (one including child posers and the other adult posers) displaying facial expressions of basic emotion and two "paralanguage" subtests (child voice and adult voice) expressing emotions by the tone of voice of the speakers who utter the same content-neutral sentence. Responses involve selecting the appropriate label from the available four choices: happy, sad, angry, and fearful. An analysis of error patterns on the various subtests of the DANVA-2 indicated that the participants with WS had difficulties differentiating among negative emotions, that recognition of facial expressions was better than recognition of vocally expressed emotions, and that across modalities, recognition of happy expressions was at the level of accuracy of age-matched typical controls (Plesa Skwerer et al., 2006). This pattern of performance was similar across comparison groups, despite difference in overall emotion recognition accuracy. The similarity in patterns of performance across groups suggests that the lower accuracy in emotion recognition demonstrated by the groups with ID reflects delay rather that atypical emotion processing strategies, at least for basic emotions.

However, evidence from studies using implicit measures of emotion processing, measures of autonomic arousal, and functional neuroimaging revealed a specific profile of processing affective information in WS. Using a visual dot-probe task (MacLeod, Mathews, & Tata, 1986) in which pairs of faces displaying happy, angry, and neutral expressions were presented briefly on a computer screen followed by a dot in the place of one of the faces, with participants being instructed to indicate the location of the dot on a button box, Dodd and Porter (2010) found that the WS group showed a greater attentional bias for happy faces compared to TD control participants matched on either chronological age or mental age. The typical response pattern in a dot-probe paradigm is faster reaction time when the dot replaced an angry face, because of the threat-related connotation of anger. Similarly, in a visual search task children with WS were less accurate in detecting the presence of angry faces "in a crowd" compared to mental age-matched

controls (Santos, Silva, Rosset, & Deruelle, 2010), and in passive viewing paradigms adolescents and adults with WS experienced lower autonomic arousal as indexed by electrodermal activity (i.e., skin conductance responses) to angry faces (Plesa Skwerer et al., 2008) or social scenes with threat-related content (Plesa Skwerer et al., 2011) compared to both TD individuals matched on age and to IQ-matched individuals with learning disabilities/ID. In a task used to examine working memory in adolescents and adults with WS, O'Hearn, Courtney, Street, and Landau (2008) found a selective advantage in memory for smiling faces, suggesting enhanced attention to positive expressions, consistent with results from other tasks probing implicit processing of affective cues in WS.

Moreover, studies that examined the neural underpinnings of affect processing in WS using fMRI have shown reduced amygdala activation in response to pictures of angry or fearful faces when compared to nonsocial scenes (Meyer-Lindenberg et al., 2005). These authors reported that, in contrast to the TD controls, the adults with WS showed a lack of activation in prefrontal regions that are highly interconnected with the amygdala, suggesting that an abnormal regulation or modulation of amygdala function by the orbitofrontal cortex could be a potential neurobiological substrate for the atypical patterns of responding to social and nonsocial threat-related stimuli exhibited by people with WS. The participants with WS in these fMRI studies were adults with average IQ, so that the particular responding demonstrated in the scanner could not be attributed to cognitive impairments (although given their unusually high IQ relative to the population average, some have argued that these participants may not be an a representative sample for WS). Haas et al. (2009) used a combined fMRI and ERP approach to investigate neural responses to emotional facial expressions in a sample of adults with WS who have ID, who were compared to typical and IDD controls. They reported greater right amygdalae activation to happy facial expressions relative to controls, but not to fearful or neutral faces. Moreover, diminished amygdala reactivity to fearful expressions in the WS group was also seen in the ERP data, indexed by decreases in the mean amplitudes of the N200, a component linked to attention and arousal, consistent with findings from fMRI tasks.

Taken together these findings converge toward defining a particular profile of affect processing in WS, marked by a reduced ability to detect social threat, and an increased attentional bias toward positive social signals (Haas & Reiss, 2012). These particular emotion processing tendencies could have direct consequences for decision making in social contexts: in particular they

may contribute to the indiscriminate friendliness and approach behavior—including toward strangers—demonstrated by many individuals with WS, behavior that may increase their vulnerability for social victimization (Fisher, Moskowitz, & Hodapp, 2013).

3.1.3 Social Appraisal

People form impressions about other people on the basis of direct perception "with remarkable rapidity and with great ease"—as Solomon Asch noted over 6 decades ago (Asch, 1946 in Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015, p. 520). Facial appearance is often the main source of information used to attribute psychological traits to strangers, such as honesty, intelligence, kindness, etc. (Zebrowitz & Montepare, 2008). These appraisals, despite being made quickly and sometimes automatically (Engell, Haxby, & Todorov, 2007; Willis & Todorov, 2006) often play a significant role in interpersonal decisions, such as whom to avoid and whom to approach. Appraisals of trustworthiness in particular are critical in many contexts of social interaction, and it is not surprising that researchers have investigated extensively trustworthiness evaluations in typical individuals, as well as in clinical populations (Adolphs, Sears, & Piven, 2001; Bellugi, Adolphs, Cassady, & Chiles, 1999; Caulfield, Ewing, Burton, Avard, & Rhodes, 2014; Martens, Wilson, Dudgeon, & Reutens, 2009).

The majority of researchers have used a task developed by Adolphs, Tranel, and Damasio (1998), which requires participants to give ratings of trustworthiness and approachability on a 1–7 scale to faces of strangers presented in photographs. Normative ratings are first established by having neurotypical adult's rate 100 stimulus faces, and dividing the set of faces into two groups—50 with most positive ratings and 50 with most negative ratings. Adolphs et al. (2001) first used this task with a small sample of adults with ASD who were asked to judge how much they would trust the person in the photograph and then to judge how much they would like to talk to the person in the photo (approach). Given the social avoidance tendencies associated with ASD, the expectation was that participants with ASD would show a bias toward negative ratings in judging trustworthiness and approachability. The opposite pattern was found: the adults with ASD gave more positive ratings of trustworthiness and approachability than the mean normal ratings when judging those faces that usually received the most negative ratings from typical individuals (Adolphs et al., 2001; Couture, Penn, Losh, et al., 2010; Losh, Adolphs, Poe, et al., 2009). Interestingly, the pattern of ratings made by the ASD group was similar to the pattern found in patients

with bilateral amygdala damage (Adolphs et al., 1998), providing indirect behavioral support for the theory that amygdala dysfunction is involved in the manifestation of autism symptoms.

Other studies however did not find any differences in trustworthiness judgments between typical adults and adults with ASD (White, Hill, Winston, & Frith, 2006). However some of these studies reported differences in psychophysiological (Mathersul, McDonald, & Rushby, 2013), and neural (Pinkham, Hopfinger, Pelphrey, et al., 2008) responses during trust evaluation tasks between adults with ASD and TD controls despite similar behavioral ratings. This finding suggests that individuals with ASD may show a qualitatively different way of processing social cues, even though they may develop over time compensatory social reasoning strategies that allow them to achieve the "typical," expected behavioral performance on tasks probing social appraisal processes.

Several variations on this task have been used in research with children with ASD, such as selecting fewer and different face stimuli and presenting faces that displayed emotions (happy and angry) in addition to emotionally neutral faces (Caulfield et al., 2014). The trustworthiness judgments of the children with ASD were influenced by emotional cues just as they were for TD children: happy-looking faces tended to be rated higher while angry-looking faces were rated lower in trustworthiness, suggesting a strong modulatory effect of emotion information on judgments of psychological traits even in children with ASD. More research is needed to assess how trustworthiness appraisals from facial appearance modulate social behavior in children and adults with ASD, using more ecologically valid tasks.

Understanding how people with WS appraise trustworthiness is particularly important because of their increased affiliative drive, often manifested in the tendency to approach, and interact with strangers indiscriminately. Early studies, using a modified version of the *Approachability/Trustworthiness task* (Adolphs et al., 1998) reported that adults with WS gave more positive ratings overall, judging the unfamiliar faces as more approachable and more trustworthy than the normative ratings for both "high trust"/positive and "low trust"/negative faces (Bellugi et al., 1999; Martens et al., 2009). These findings were interpreted as evidence in support of the hypothesis that amygdala dysregulation is involved in the unique social–behavioral profile demonstrated by people with WS, who are thus less alerted to the implicit "danger" cues that untrustworthy faces convey. Studies using emotionally expressive faces as stimuli for judgments of trustworthiness and approachability reported that the WS group rated only the *happy* faces as more

approachable than the matched controls (Frigerio et al., 2006). Similar modulation of trustworthiness judgments by expressed facial emotion has been reported for children with ASD, as previously noted, and is consistent with the pattern found in younger TD children. Porter et al. (2007) administered a test of emotion recognition to the same participants who rated emotionally expressive faces for trust and approachability. They found that for those expressions that were correctly recognized, the WS group displayed the same rank order of approachability judgments as the typical controls. This finding suggests a strong relation, at a conceptual level, between emotion recognition abilities and judgments of approachability, but this is not reflected in the real-life behavior of people with WS. These authors interpreted their findings as evidence for a dissociation between "knowing" (e.g., that strangers should not be approached) and "doing" (e.g., the tendency to approach strangers in real life), which could be explained by an impairment in response inhibition, not by strong biases in social appraisals related to amygdala dysfunction.

Another approach that provided further insights into the actual process—cognitive dynamics—of making evaluative decisions was adopted by Martens, Hasinski, Andridge, and Cunningham (2012). These researchers employed a "mouse-tracking technology" to trace the participant's hand movements while he/she was deciding to respond using the computer mouse. This computer mouse-tracking procedure made it possible to visually observe and quantify the competition between responses before the final approach/avoid decision was made, thus capturing the continuous cognitive dynamics of social-evaluative judgments as they occurred in real time. The results demonstrated that the WS group showed an *approach bias* in their increased tendency to initially deviate toward untrustworthy faces, despite discriminating between mild and extreme degrees of trustworthiness in their final response, as did the typical controls. Therefore, it is likely that many individuals with WS are able to suppress their "default" approach tendency when instructed to make a deliberate judgment about a person shown in a photograph, but often fail to do so in the context of real-life interactions.

More recently, Shore, Ng, Bellugi, and Mills (2017) recorded electrophysiological data (ERPs) while adults with WS and TD adults viewed and rated on trustworthiness and approachability faces displaying a neutral expression. While the groups did not differ significantly in their behavioral responses, the ERP data showed that both the timing and the organization of neural activity related to social evaluations was atypical in the adults with

WS, who showed enhanced brain activity to trustworthy faces, in contrast to the increased sensitivity to untrustworthy faces showed by the TD controls within the first 65–90 ms of viewing a face.

As the studies and findings described above demonstrate, using a combination of methods to probe the processes underlying behavioral responses on a particular task may provide the means to detect qualitative differences in how people with neurodevelopmental disorders respond to and use social information, when their performance on behavioral tasks is on par with that of control groups or TD individuals.

People use perceptual cues to make assumptions not just about individual psychological traits but also about other characteristics associated with perceived group membership, as illustrated by the process of stereotyping. "Stereotyping occurs when perceptually-available cues are used to categorize a person in terms of a social group membership (e.g., race, sex, occupation), and then generalized beliefs about the social group are recruited from memory and applied to the individual in question" (Bodenhausen & Morales, 2013, p. 236). In typical development certain stereotypes are acquired very early—such as gender stereotypes or racial stereotypes manifested by the age of 3 years (Aboud, 1993; Hirschfeld, 1995). Stereotyping processes rely on generic social knowledge that is culturally transmitted; substantial learning about kinds of people takes place through implicit cultural cues, so it is reasonable to assume that social participation provides the necessary context for acquiring this knowledge. Several instruments have been designed to "measure" stereotype-related biases, including a measure adapted for young children, the preschool racial attitudes measure (Williams, Best, & Boswell, 1975; PRAM II). This measure consist of various scenarios involving cartoon characters (boys, girls, of dark-skin-color and of white-skin-color), and the child is asked to indicate the person who, for instance, is friendly (between a dark-colored and a white cartoon character) or has four dolls (between a boy and a girl).

The lack of social interest and the diminished motivation for social engagement shown by individuals with ASD (Chevallier et al., 2012) were expected to result in diminished opportunities for social learning among children with autism. Therefore, researchers hypothesized that children with ASD may show no or reduced gender and racial biases compared to TD peers. Contrary to expectations, when 8-year children with ASD with a mental age of about 7 years, who failed false-belief tasks, were tested on the PRAM II measure, they used gender and racial stereotypes just like the TD children did (Hirschfeld, Bartmess, White, & Frith, 2007).

By contrast, 7–16-year-old children with WS who were administered the same test appeared to show no racial bias in their responses, as they attributed positive and negative features equally to Caucasian (in-group) and non-Caucasian (out-group) characters, although they did show "typical" gender stereotypes on more than 90% of their responses, comparable to the stereotyping rate shown by the TD group of children who were matched individually on mental age with the 10 children with WS tested in the study (Santos, Meyer-Lindenberg, & Deruelle, 2010). The TD children in the study, as expected, attributed negative features to the characters perceived as different (other ethnic group) 83% of the time, exhibiting a strong bias toward their own group. Racial stereotyping is thought to be in part based on fear of those perceived to be different from us (Olsson, Ebert, Banaji, & Phelps, 2005), and the lack of racial biases shown by the children with WS might be explained by their lack of social fear. Perceptually, children with WS are sensitive to race—as demonstrated by measures of brain response (ERP) indexing the other race effect (Fishman, Ng, & Bellugi, 2012), but their attributions of negative characteristics to the "other race" did not differ from chance (63% of their responses). Santos, Silva, et al. (2010) and Santos, Meyer-Lindenberg, et al. (2010) hypothesized that the apparent lack of racial bias demonstrated by the children with WS may be a result of the reduced activity in the amygdala and its abnormal interactions with other brain areas, leading to diminished signaling of the social threat implicitly associated with the perception of an ethnic out-group in our society/culture. However, other researchers cautioned that the small sample size in the study is a concern for the interpretation of the results, underscoring the need for replications with a larger sample and a narrower age range.

Taken together these surprising findings showing racial stereotype formation in children with ASD but not in those with WS, raise intriguing questions about the mechanisms underlying social appraisals, and their relation to processes of implicit and explicit social learning, a topic that has not been much researched in any clinical populations, despite its relevance for understanding the development of social cognition and for discovering why it becomes derailed in many developmental disorders.

3.2 Social Inferencing

3.2.1 Mentalizing Abilities/Theory of Mind (ToM)

At the core of social cognition is the human ability to ascribe mental states—such as thoughts, desires, knowledge, beliefs, and intentions—to self and others, in order to understand and predict behaviors. This core aspect of

social cognition is commonly referred to as ToM or mentalizing ability (Premack & Woodruff, 1978; Whiten, 1991). We use this ability to "read minds" in our everyday interactions, effortlessly, automatically, and often unconsciously.

This is not usually the case for children with autism who habitually seem unaware of people's mental states, leading researchers to hypothesize that a specific cognitive impairment in ToM constituted the primary deficit in ASD: an inability to represent mental states (Baron-Cohen, 1995). Early evidence of this impairment was first presented in a seminal article by Baron-Cohen, Leslie, and Frith (1985), who showed that 80% (i.e., 16 of 20) of children and adolescents with autism (aged 6; 1–16; 6 years) were unable to pass a false-belief task (Wimmer & Perner, 1983) that typical preschool children and children with DS of similar chronological age and of lower verbal mental age than the ASD group were able to succeeded on.

The classic false-belief tasks require children to predict the action or thoughts of a protagonist who is unaware of a change in the location (e.g., the "Sally—Anne" task, the "Maxi" task) or the content of an object (e.g., the "Smarties" task), and therefore will act based on a false belief, thinking about the object something that the child knows is not true. Such first-order false-belief tasks are passed by TD children at around 4 years of age. More complex forms of mentalizing emerge gradually over the school years and later in typical development. These include second-order false-belief understanding (thinking about what a person thinks that another person believes), and higher-order belief attribution involving embedded mental states, understanding faux pas, double deception, and the role of intentionality in interpreting nonliteral utterances (e.g., ironic remarks, sarcasm, distinguishing lies from jokes, humor, and figurative speech). A large number of tasks were developed to assess these "advanced ToM" abilities, usually in the form of narratives that describe social situations, sometimes accompanied by cartoons/drawings (e.g., the "Strange Stories Task"—Happé, 1994) or, more recently, in the form of film segments to use more ecologically valid stimuli (e.g., Reading the Mind in Films Task, Golan, Baron-Cohen, Hill, & Golan, 2006; the Movie for the Assessment of Social Cognition—MASC, Dziobek et al., 2006; the Awkward Moments Test, Heavey, Phillips, Baron-Cohen, & Rutter, 2000), and participants are required to make inferences about the mental states of the characters whose actions, and/or utterances are portrayed in the task.

The "theory of mind deficit" hypothesis dominated research in autism for several decades (Baron-Cohen, 1995; Baron-Cohen, Lombardo, &

Tager-Flusberg, 2013; Baron-Cohen, Tager-Flusberg, & Cohen, 1993, 2000), even though its universality (i.e., has to be present in all or almost all individuals with ASD) and its uniqueness/specificity (i.e., has to differentiate individuals with ASD from individuals with other conditions) have been questioned from the beginning (Corcoran, 2000). As the data from Baron-Cohen et al. (1985) showed a number of individuals with ASD do pass false-belief tasks albeit with some developmental delay compared to TD peers. Delays in the behavioral success of children with ASD on first-order false-belief tasks have been widely reported, and analyses of the relations between ToM performance, age, and language abilities have usually singled out language as the main contributor to ToM (Happé, 1995; Lind & Bowler, 2009; Steele, Joseph, & Tager-Flusberg, 2003). Using vocabulary knowledge as the measure of language in one the first analyses of these relations, Happé (1995) showed that children with ASD needed to have a higher lexical–semantic skill level than nonautistic children to solve false-belief problems; more specifically, she found that only when they reached the verbal mental age of about 9 years children with ASD tended to perform at ceiling on such tasks. Later studies found correlations between performance on ToM tasks and various other dimensions of language ability (grammar/syntax, knowledge of cognition and communication verbs, pragmatics), which are implicated in different ways in promoting ToM development (Abbeduto, 2004; de Villiers, 2005; Fisher, Happé, & Dunn, 2005; Tager-Flusberg, 2000) but these relations did not fully explain the significant delays in false-belief comprehension shown by individuals with ASD.

Impairments and significant delays in ToM development have been documented in a variety of neurodevelopmental disorders, such as ADHS (Mary et al., 2016), FXS (Cornish et al., 2005), PWS, WS, and schizophrenia (see for review, Kormaz, 2011), in deaf children of speaking parents (de Villiers, 2005; Peterson & Siegal, 2000), in congenital blindness (Garfield, Peterson, & Perry, 2001; Peterson, Peterson, & Webb, 2000), as well as in individuals with IDD of unknown etiologies who have limited narrative language skills (Abbeduto, 2004; Yirmiya, Solomonica-Levi, Shulman, & Pilowsky, 1996).

Studies with preschoolers with ASD almost invariably found lower performance on a variety of ToM tasks, such as, according to a review by Baron-Cohen (2001): understanding the mental–physical distinction, the functions of the mind, the appearance–reality distinction (Baron-Cohen, 1989), first-order false-belief tasks (Baron-Cohen et al., 1985; Baron-Cohen, Leslie, & Frith, 1986; Reed & Peterson, 1990; Swettenham,

1996), "seeing leads to knowing" tests (Baron-Cohen & Goodhart, 1994; Leslie & Frith, 1988); tests of understanding deception (Baron-Cohen, 1992; Sodian & Frith, 1992; Yirmiya, Solomonica-Levi, et al., 1996), more complex causes of emotion (Baron-Cohen, 1991), and tests of imagination and production of spontaneous pretend play (Baron-Cohen, 1987; Lewis & Boucher, 1988); and tests of understanding intentions in the use of language (e.g., telling a lie, irony, and sarcasm; Tager-Flusberg, 2000). Many children with ASD improve over time in their mentalizing abilities, along a mostly typical trajectory (Steele et al., 2003): they become successful on ToM tasks gradually, starting to pass increasingly complex tests in the same successions as TD children do (see developmental succession in scaling ToM tasks in Wellman & Liu, 2004), with one exception, according to a study by Peterson, Wellman, and Liu (2005)—they found understanding "hidden emotions" easier than "false belief," whereas among the TD and deaf children the order of passing these tasks was reversed (Peterson et al., 2005).

Given that children with ASD show developments in ToM abilities, and some, especially among those without ID, catch up with the performance of their TD peers, it is not surprising that reports of advanced ToM reasoning assessed in adolescents and adults with ASD have been equivocal: while some studies have reported deficits on advanced ToM tasks (Brent, Rios, Happe, & Charman, 2004; Mathersul et al., 2013), others reported no significant differences in performance between high-functioning school-age children, adolescents, and adults with ASD- and age-matched TD controls, on understanding second-order false beliefs, display rules, double bluff, faux pas, and sarcasm, when participants were tested in research settings (Bowler, 1992; Peterson, Slaughter, & Paynter, 2007; Scheeren et al., 2013). High-functioning adults with ASD tend to be successful on advanced ToM tasks especially when these are presented in the structured form of social stories or cartoons that require reasoning about the mental states of the protagonists based on social situations clearly described in the narrative or sequence of pictures (Happé, 1994). In structured experimental settings high-functioning individuals with ASD could perform well by using compensatory reasoning and verbal mediation strategies (Ponnet, Buysse, Roeyers, & De Clercq, 2008).

However, even high-functioning adults with ASD usually perform worse than TD peers on more "intuitive" tests of mental state recognition, such as the "Reading the mind in the eyes" task (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001) or "Reading the mind in the voice" task (Golan,

Baron-Cohen, Hill, & Rutherford, 2007; Rutherford, Baron-Cohen, & Wheelwright, 2002). These tests require participants to recognize subtle emotions and mental states from pictures of the eye region only, and from segments of speech, respectively, by selecting one out of four, or one out of two words (depending on the version of the task) that best describes the mental state of the person whose eye-region or speech/voice are presented as stimuli, respectively.

It is possible that many individuals with ASD, especially those with normal IQ, are able to "learn" to perform correctly on laboratory tasks in which a particular answer is expected, but show impairments when having to interpret more complex social cues and situations that require them to analyze other people's thinking and intentions. For instance, making moral judgments requires taking into account both intentions and outcomes when evaluating a person's actions/behavior and sometimes the two are in conflict (e.g., good intentions result in accidental harm, or harmful intentions fail to produce intended damage). Moran et al. (2011) created such scenarios in which a protagonist's intention and the outcome of her actions conflicted, and asked high-functioning adults with ASD and neurotypical controls to rate the moral permissibility of the action on a 7-point scale. While the majority of the TD adults exculpated the protagonist for accidental harm resulting from innocent intentions, the adults with ASD gave more weight to the negative outcome, relying less on the information about the innocent intentions when evaluating the moral permissibility of the action, a pattern of moral judgment also shown by much younger TD children. Up to about 5 years, TD children tend to assign blame for harmful outcomes to the protagonist, even when they are informed about the innocent initial intentions (Mant & Perner, 1988; Shultz, Wright, & Schleifer, 1986). Nevertheless, on tests of moral judgment that imply distinguishing between "right" and "wrong," prosocial acts and antisocial acts (Killen, 1991), and between moral and conventional transgressions (Blair, 1996; Leslie, Mallon, & DiCorcia, 2006) children with ASD performed at the level of their age-matched TD controls, and moreover, understanding of these basic moral distinctions was not related to ToM ability (e.g., children with ASD who did not pass false-belief tests succeeded on the tests of moral judgment—see Kretschmer, Lampmann, & Altgassen, 2014; Leslie et al., 2006).

These mixed findings about the ToM abilities of individuals with ASD underscore the need for more sensitive tasks that could capture the subtler differences in the ways they process social information, to begin to understand why their competence on ToM tests does not translate into social

interaction skills used in real life. Such tasks may target implicit processing of mental state information, as signaled by behavioral or physiological responses that do not rely on verbal reasoning, such as eye movements. For instance, Senju (2011) examined participants' eye movements recorded with eye-tracking technology, during simple nonverbal scenarios involving a false belief, based on an unexpected change of location paradigm (i.e., an object is moved from one box to another while the protagonist is not looking). While in this type of task typically developing infants as young as 18 months (Baillargeon, Scott, & He, 2010) have been shown to make eye movements toward the box consistent with the protagonist's (false) belief about the location of the object, the adults with ASD in the study failed to make *spontaneously* the anticipatory eye movements reflecting belief attribution, although they passed with ease the standard (verbal) false-belief task giving the correct verbal answer predicting the protagonist's behavior. It should be noted however, that the hypothesis of an "implicit ToM" evident in infancy in typical development, especially the interpretation that infants track mental states when watching a simple sequence of events in which a protagonist is expected to hold a false belief, is a topic of heated debate in developmental psychology. This raises questions about possible alternative explanations for the eye-movement behavior exhibited by adults with ASD when presented with this visual task, besides their lack of spontaneous false-belief attribution, which has been interpreted as indicating an ASD-specific ToM deficit.

As these recent studies suggest, even when their behavioral performance is on par with that of TD controls, individuals with ASD may show different patterns of brain activation and other subtle spontaneous looking or physiological responses (e.g., elevated or dampened arousal level), which may explain why they often have disabling difficulties with the fluctuating, rapid paced, sometimes chaotic and often unpredictable nature of real-life social interactions (Klin et al., 2003).

Individuals with WS have a heightened appetitive drive for social interaction (Jarvinen-Pasley et al., 2008) are interested in people, are gregarious, friendly and have relatively good face recognition and expressive language abilities. Based on these aspects of the behavioral and neuropsychological profile of children and adults with WS, which distinguishes them from people with other IDDs (Klein-Tasman & Mervis, 2003), researchers initially hypothesizes that people with WS would have a good understanding of the social world, showing domain-specific sparing in social cognition or ToM (Karmiloff-Smith, Klima, Bellugi, Grant, & Baron-Cohen, 1995; Tager-Flusberg, Boshart, & Baron-Cohen, 1998). One early study

(Karmiloff-Smith et al., 1995) reported that, in contrast to those with autism, the majority of the participants with WS tested passed standard first-order and higher-order belief tasks, leading the researchers to conclude that ToM might be an "islet of preserved ability" in WS (Karmiloff-Smith et al., 1995, p. 202). However, the individuals with WS in that study were much older (ranging from 9 to 23 years) than the age at which TD children pass such ToM tests (Brock, Einav, & Riby, 2009) and no comparison group was included in that study, which renders the findings difficult to interpret in terms of sparing or impairment in mentalizing abilities.

Later studies of children and adolescents with WS found that their performance on ToM tasks was no better than that of other participants with ID matched on age and IQ. Tager-Flusberg and Sullivan (2000) investigated performance on a series of age appropriate ToM tasks in younger children and in adolescents with WS, who were matched on age, IQ, and standardized language measures to two comparison groups: children and adolescents with PWS (another genetic developmental disorder with a different cognitive and social phenotype, but similar IQ distribution as the WS), and children and adolescents with nonspecific ID. Overall, their findings showed that the children with WS performed no better than the matched comparison groups on three different first-order false-belief tasks, while adolescents with WS performed on par with the comparison groups on second-order belief reasoning (Sullivan & Tager-Flusberg, 1999), on distinguishing between lies and jokes (Sullivan, Winner, & Tager-Flusberg, 2003), and on using trait information to attribute intentionality (Plesa Skwerer & Tager-Flusberg, 2006). Across these latter higher-order social reasoning tasks the majority of the participants with WS had difficulty passing test questions, and especially in justifying their answers by correctly referring to mental states, as did those in the comparison groups. So far tests of moral reasoning have not been conducted with WS individuals, but Tager-Flusberg and Sullivan (2000) tested how children with WS reasoned about keeping or breaking promises (Mant & Perner, 1988). They found that the children with WS were not able to differentiate between intentional and unintentional violations of a promise (e.g., a protagonist decided not to go to the appointment vs her bike broke down and she was not able to arrive at the appointment), judging both types of outcomes as equally "bad" and the protagonist as culpable for the broken promise in both scenarios.

Taken together these findings show that children and adolescents with WS exhibit problems in social-cognitive abilities that involve making

inferences from narratives to interpret mental state information. It is unlikely that the difficulties shown individuals WS could be attributed to the "story" format of the tasks, given that many people with WS have relatively good language abilities relative to their mental age and they passed memory control questions with ease. To minimize the possible impact of verbal demands on task performance, Porter et al. (2007) administered a nonverbal ToM task assessing understanding of pretense, intention, and false belief by using a picture sequencing method. Compared to groups of TD controls (matched on chronological age and matched on mental age, respectively), the individuals with WS showed a specific impairment in understanding false belief, although there was significant heterogeneity in performance within the WS group (Porter et al., 2007). In a study in which performance on a verbal form of a ToM task probing understanding of intention was compared directly to an equivalent visual task, Santos and Deruelle (2009) found an advantage for the verbal task, consistent with the WS profile of better verbal relative to nonverbal abilities.

What about tasks that do not require explicit inferences and reasoning about social situations, such as the "Reading the Mind in the Eyes" test (Baron-Cohen et al., 2001)? In an early study conducted with a small sample of adults with WS using the original eyes task (Baron-Cohen et al., 1997), which included, for each photograph, two semantically opposite mental state labels (e.g., concerned–unconcerned; friendly–hostile) and the participant was asked to select which one best matched the expression depicted, the WS group performed significantly better than a group of adults with PWS, matched on age, IQ, and language (Tager-Flusberg et al., 1998). However, given the way the labels were paired, the participants with WS may have relied simply on choosing between positive or negative valenced terms, a strategy that does not require attribution of mental states. A later study included a large sample of adolescents and adults with WS who were administered an adapted version of the revised methodologically improved "Reading the mind in the Eyes" test (Baron-Cohen et al., 2001) and their performance was compared to that of age-matched TD controls, and to a group of age- and IQ-matched participants with ID of mixed etiology. The performance of the participants with WS was significantly worse than that of the normal controls and no different from that of the group of age- and IQ-matched adults with ID of mixed etiologies, indicating that even on a more intuitive task of social perceptual mentalizing ability, people with WS show no relative sparing, as initially predicted (Plesa Skwerer et al., 2006).

This selective overview of ToM research conducted with children, adolescents, and adults with ASD and with WS, indicates that, contrary to initial expectations, the two neurodevelopmental disorders are more similar than different with respect to the sociocognitive abilities required to succeed on mentalizing tasks, despite the striking differences between people with ASD, and those with WS in social interest and engagement.

3.2.2 Social Perspective Taking and Empathy

Social perspective taking refers to understanding another person's psychological stance, such as understanding their preferences, goals, intentions, desires, etc., based on prior interactions and communication with the person. It is made possible by the formation of common ground with others, based on shared experiences (O'Neill, 1996; Repacholi & Meltzoff, 2007).

Empathy had been defined in many different ways in the psychological literature (Davis, 1996; Eisenberg & Fabes, 1990; Preston & de Waal, 2002 for reviews), sometimes overlapping with the notion of social perspective taking, especially when researchers propose a distinction between "cognitive empathy" and "affective empathy" (Blair, 2005; Davis, 1996). In this chapter, empathy is conceptualized primarily as the ability to understand and *respond appropriately* to the affective states of another person. Recognizing and responding to others' emotional experiences is an important aspect of social functioning, facilitating our affective connectedness with other people. The relation between emotional responsivity and understanding another person's psychological perspective though, is not straightforward, but is mediated by individual cognitive, personality-related, and experiential factors. It is not surprising that behavioral research has yielded findings suggesting impairments in social perspective taking and empathy in individuals with ASD, and heightened empathy in individuals with WS (Baron-Cohen & Wheelwright, 2004; Dawson et al., 2004; Peterson, 2014; Plesa Skwerer & Tager-Flusberg, 2016; Sigman, Kasari, Kwon, & Yirmiya, 1992; Tager-Flusberg & Sullivan, 2000). However, more recent studies have suggested a more mixed picture of strengths and weaknesses in both disorders in these areas of social-cognitive and affective abilities, and revealed complex relations between emotional responsivity and aspects of social reasoning in children and adults with ASD and WS, respectively (Fidler, Hepburn, Most, Philofsky, & Rogers, 2007; Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007).

Early descriptions of autistic children—starting with Kanner's (1943) original report—have almost invariably noted a lack of emotional

responsiveness to others, even when the child's own mother appeared to be in distress. These early observations were corroborated by findings from experimental research probing empathic concern in children with ASD relative to various control groups of TD children or children with IDD. A commonly used paradigm designed to probe empathic concern in a semi-naturalistic situation involves an adult (experimenter or child's parent) accidentally hurting their knee (on a table corner) or hand (with a toy hammer), and displaying overt signs of pain and distress for a predetermined amount of time, and other similar scenarios that have been used less often in research with nonautistic populations (Sigman et al., 1992). In many studies using a version of this paradigm, across the various scenarios, children with ASD were reported to show less concern than age or verbal mental age-matched TD children or children with IDD, as measured by behavioral indices usually coded from videotapes of the interaction (e.g., looking time toward the person in distress, verbal comments, and expressed concern, offers to help). The relative lack of emotional expressiveness toward the displays of distress of a caregiver was reported in one of the first studies that involved infants at risk for ASD. McDonald and Messinger (2012) found that children later diagnosed with an ASD engaged in less empathic responding at 24 and 30 months than children with no later diagnosis. Moreover, lower empathic responding was associated with higher autism symptomatology at 30 months, concluding that levels of empathic responding prior to an autism diagnosis may predict later ASD severity.

Hobson, Harris, García-Pérez, and Hobson (2009) were interested in whether school-age children with ASD would show "anticipatory concern"; they investigated children's reactions while witnessing an unkind act done to another person (i.e., an experimenter tears in pieces that person's prized drawing in front of them), before the "victim" displays any emotional reactions (Hobson et al., 2009). On this task that requires predicting another person's subjective experience instead of just reacting to another's overt expression of distress, the children with ASD showed fewer concerned looks toward the person who was "wronged" compared to the mental age-matched controls with ID and TD, a finding interpreted by the authors as reflecting a limited propensity to identify with another, a process essential for developing social perspective taking and empathic abilities.

Not all seminaturalistic observational paradigms revealed significant differences when older children and adolescents or adults with ASD were tested in lab settings, by comparison to TD controls. For instance, Scheeren et al. (2013) used two scenarios to probe empathic responsiveness

in high-functioning children and adolescents with ASD: in one an experimenter received very good news and in the other she received very bad news via a text on her phone and "acted" in accordance to the expected emotions—very happy or distressed during a testing session with the participant (Scheeren, Koot, Mundy, Mous, & Begeer, 2013). These researchers reported that for both scenarios adults with ASD displayed appropriate reactions to the experimenter's emotional displays, being rated no different from the TD controls on empathic responsiveness. However, even for those who reacted appropriately (empathically) in the lab setting, parental reports of empathy in everyday life showed significant differences between groups. Similarly, teacher reports of empathy also differentiated children with ASD from TD children (Peterson, 2014), consistent with the lower ratings of empathy usually indicated by the caregivers of children, adolescents, and adults with ASD. While studies with young children almost invariably showed less empathy in the children with ASD compared to controls, in studies with older children, adolescents, and adults with ASD group differences in empathy ratings are not always found. There are several possible interpretations of the behavioral changes found in seminaturalistic scenarios in lab settings between younger and older children with ASD: it is possible that there is a genuine development in the empathic abilities of the children with ASD over time, or they may have just learned the expected responses in such situations from experience or from direct teaching received at home or at school and are able to apply this knowledge appropriately. Longitudinal studies and assessments of empathy across a variety of contexts are needed to clarify the nature of the behavioral changes in empathic responsiveness that tend to become apparent between younger and older children with ASD at least in seminaturalistic scenarios. Nevertheless, unlike reports from other areas of social cognition (e.g., recognizing emotions and ToM abilities), it appears that diminished empathic reactions to other people's emotional displays is a consistent finding across studies from infants at risk for autism to adults with ASD.

Partly based on such results Baron-Cohen (2002, 2009) expanded the ToM deficit explanation of autism to include more general cognitive and affective styles that differentiate those with ASD from neurotypical individuals, along the lines of an exaggerated "male brain" type of cognitive style, characterized by a strong preference for "systemizing," defined as "the drive to analyze or construct systems" that "follow rules," in contrast to a "female brain" processing style, characterized by an "empathizing" style defined as "the drive to identify another person's emotions and thoughts, and to

respond to these with appropriate emotion" (Baron-Cohen, 2009). According to this view people with ASD are "hyper-systemizers," likely to excel in knowledge of the physical world but have a poor understanding of the social world. The author suggests that the opposite should be true for people with WS, who are considered exceedingly empathic compared to other people with ID and even to neurotypical controls, showing a strong drive toward "empathizing." This approach does not distinguish between "cognitive" and "affective" empathy, assuming that emotional responsivity and social perspective taking are closely intertwined and are primarily characteristics of the "female brain" cognitive style. However, empirical research has revealed more complex relations among these aspects of social-cognitive and affective behaviors, as discussed below.

Clues about the reasons why people with ASD tend to be rated as less empathic than controls come from people with ASD themselves, especially those high-functioning individuals who are able to respond to interviews and questionnaires probing their insight into their subjective experiences. On self-reports of empathy, such as the interpersonal reactivity index (IRI, Davis, 1983), a multidimensional questionnaire comprising two cognitive empathy subscales (perspective taking and fantasy) and two affective empathy subscales (empathic concern and personal distress), adults with ASD scored lower on the measures of cognitive empathy but were no different from controls on one affective empathy scale (empathic concern), and scored higher than controls on the other (personal distress), suggesting that a possible reason for the lack of overt signs of empathic response to others' displays of emotion may be a heightened sensitivity to affective stimuli, which may be experienced as overwhelming and distressing (Rogers et al., 2007). This interpretation is consistent with recent findings from studies using psychophysiology recordings (Dalton et al., 2005; Joseph et al., 2008; Kylliainen & Hietanen, 2006; Mathersul et al., 2013) and brain imaging (Hadjikhani et al., 2017), that showed unusual arousal levels in situation in which individuals with ASD are expected to or instructed to look at people's faces, and focus on the eyes, especially when the faces display emotions. Hadjikhani et al. (2017) noted that the eye avoidance (considered to index apparent lack of empathic responsivity) that has been traditionally interpreted as interpersonal indifference to others, may be a matter of socioaffective oversensitivity, as suggested by first hand reports from verbal people with ASD (Brewer & Murphy, 2016).

The same seminaturalistic scenarios described above have been used to probe empathic concern in children with WS—who were compared, across

studies, to a variety of age- and IQ-matched control groups, such as children with PWS (Tager-Flusberg & Sullivan, 2000), children with DS (Kasari, Freeman, & Bass, 2003; Plesa Skwerer & Tager-Flusberg, 2016), children with IDD of nonspecific etiologies and TD children. Across studies, comparisons on several behavioral manifestations of empathy suggested that the children with WS displayed more concern than control groups by prolonged gaze, approaching the person in distress, touching or commenting with intentions to comfort. However, in a study in which the same 3–5-year-old children involved in the empathy probing episodes described above were assessed for prosocial behavior (e.g., helping an adult pick up beads accidentally spilled on the floor next to the child or responding to the adult's request for help to fold a long collapsible toy tunnel), children with WS were no more helpful than the age- and IQ-matched children with DS, and both groups with ID provided help significantly less (in terms of duration, frequency of spontaneous help, and responding to requests for help), than the TD children did (Plesa Skwerer & Tager-Flusberg, 2016), suggesting that empathic concern does not necessarily lead to prosocial behavior, especially when there is no obvious emotional component in the potential social interaction involved in the situation. Another form of disconnect between emotional responsivity and social competence in children with WS was reported by Fidler et al. (2007) who compared children with WS matched on mental age with children with IDD of nonspecific etiologies on a task of social perspective taking (Repacholi & Gopnik, 1997). In this study, children were asked to give a food item to an experimenter based on that adult's like or dislike for the food, clearly expressed by facial and vocal cues. Although the children with WS were more likely to mimic and imitate the emotional display and vocalizations of the adult, they did not choose the appropriate food based on the adult's preference, but most of the time made the giving decision based on their own likes and dislikes. Therefore the authors concluded that the elevated emotional responsivity shown by the children with WS did not translate into competent social behavior that would rely on the ability to take another person's perspective.

Taken together, these findings indicate that, despite their heightened affective empathy, children with WS have a poor grasp of another person's perspective and needs, and these difficulties with cognitive aspects of empathy or perspective taking are likely to have negative consequences over time, hindering their ability to form friendships, and other meaningful relationships that involve a mutual understanding of the mental world of the partners, besides the simple rewards of affective contact.

4. PRECURSORS OF SOCIAL-COGNITIVE ABILITIES AND SOURCES OF SOCIOCOGNITIVE DIFFICULTIES IN IDD

The developmental relations between social-cognitive and communicative abilities and early forms of social engagement behaviors such as social referencing, joint attention, and imitation have been explored extensively in typical development and more recently in neurodevelopmental disorders. Many studies showed concurrent and longitudinal relations between joint attention or imitation and language ability for children developing typically (Baldwin & Moses, 1996; Tomasello, 1995) and for children with ASD (Charman et al., 1997; Landa & Garrett-Meyer, 2006). Developmental hypotheses have been proposed to explain the sources of impairments in social cognition primarily for children with ASD. There are surprisingly few studies of infants with WS or with other syndromes with knows genetic origin, although the availability of genetic testing renders many of these disorders detectable prenatally or very early in life.

Because ASD is a disorder diagnosed behaviorally and reliable diagnoses are usually given around the child's third birthday, researchers have initially turned to home videotapes for clues about the possible behavioral precursors of ASD symptoms (Clifford, Young, & Williamson, 2007; Osterling & Dawson, 1994). In one of the first studies of home videotapes of infants' first birthdays, Osterling and Dawson (1994) found that failure to attend to other people's faces was the best discriminator between children with and without autism, suggesting that impairments in social cognition in children with autism might be due to early impairments in face processing abilities.

The development and use of screening instruments designed to detect early signs of ASD (e.g., Baron-Cohen et al., 1996, Checklist for Autism in Toddlers—CHAT) made it possible to include in experimental studies younger children that met criteria for ASD (e.g., 18 months; see Charman et al., 1997), but the majority of findings potentially relevant for uncovering the developmental origins of the sociocognitive impairments associated with autism have come from prospective studies of the developmental trajectories of very young siblings of children already diagnosed with ASD (Elsabbagh & Johnson, 2007; Rogers, 2009; Yirmiya & Sally Ozonoff, 2007). The likelihood of developing ASD for these infants with an affected sibling is about five times higher than that of infants from families with no history of ASD (Ozonoff et al., 2011). The "high risk for ASD" infants (HRI) may be tested much earlier than the time when behavioral signs of ASD emerge.

Later (e.g., at 36 months) all infants included in a study are evaluated for ASD. The behavior/performance in the area of interest shown by the HRI who went on to develop autism (HRI +) is compared to that of the HRI who did not meet criteria for ASD later (HRI −), in addition to comparing both these groups to TD controls, who were considered "low risk" infants (LRI). The same comparisons are possible for electrophysiology and for eye-tracking data, which may be collected at very young ages. This methodology enables researchers to detect aspects of behavior and of neural activity that may have predictive value for later ASD diagnosis, and may guide the development of early interventions to improve outcomes for children with ASD. Many of the studies described below involve these groups of infants.

4.1 Social Orienting and Social Attention

Understanding people and learning about the social world are greatly facilitate by humans' propensity to orient toward social aspects of their environment (human faces, biological motion connoting agency, and speech sounds) from birth (DeCasper, 1980; Macchi Cassia, Simion, & Umiltaà, 2001; Simion, Regolin, & Bulf, 2008; Striano & Reid, 2006). Deficits and strengths in social cognition may be partly explained by atypicalities in the development and manifestations of this foundational ability to orient attention toward socially relevant features of the surroundings (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Klin, Lin, Gorrindo, Ramsay, & Jones, 2009). Researchers have attempted to trace some of the sociocognitive impairments seen in ASD to early disruptions in the process of attending preferentially to social stimuli and of assigning special significance and reward value to engagement with these stimuli (e.g., with human faces and voices). There are several behavioral paradigms that may provide direct clues about how infants and young children who do not develop typically relate to social partners: these include various versions of the "still-face paradigm" and assessments of social referencing, joint attention, and imitation.

4.1.1 Still-Face Paradigm

The "Still-Face Paradigm" (Tronick, Als, Adamson, Wise, & Brazelton, 1978) explores an infant's response to contradictory messages in face-to-face interaction, when the adult who had been actively engaged in a playful manner with the child abruptly stops the interaction and keeps a still face for a predetermined amount of time. The classic still-face effect is manifested as

reduction in the infant's positive affect and gaze, and increase in negative affect during the interruption in the face-to-face interaction. How do infants with ASD react to this situation? The few studies that used the still-face paradigm with 6 months old "infants-at-risk-for autism" (those with an older sibling with ASD), reported that the reactions of these infants were very similar to those of the TD infants (Cassel et al., 2007; Merin, Young, Ozonoff, & Rogers, 2007; Yirmiya et al., 2006), despite some general differences in social behavior between groups (Yirmiya et al., 2006). However, when a modified version of this paradigm was used with older (5–13-year-olds), nonverbal low-functioning children diagnosed with ASD (Nadel et al., 2000) results showed a pattern of behaviors contrasting that of typical infants: none of the children with ASD showed concern with the still behavior of the adult during a first still-face episode, suggesting they did not form generalized expectations about the behavior of a stranger since they did not react to the violation of the contingency social rule. Nevertheless, after the adult interacted in an imitative way with the child for several minutes and then produced a second still-face episode, the children showed an increase in negative affect and in looking away, resembling the still-face effects found in typically developing infants. The authors concluded that the children with ASD were able to integrate their previous experience with the stranger and detect a violation of social contingency, but may not be able to form a generalized expectancy for social contingency in human behavior, independent of their immediate prior experience with a particular person. Given the small sample size of this pilot study more research and replication studies are needed to provide evidence for this or for alternate interpretations of children's behavior when presented with a violation of a social rule.

4.1.2 Social Referencing Studies

Social referencing is demonstrated by TD infants within the first year of life (Striano & Rochat, 2000) and is an important way of learning about one's environment and about how to behave when encountering unfamiliar situations (Feinman, 1982). The social referencing process comprises a social information seeking component (looking to an adult when confronted by an ambiguous stimulus or situation) and a behavior regulation component (modifying behavior toward the ambiguous stimulus/situation in accordance with an emotional signal given by the adult), behaviors that imply several sociocognitive abilities: the child needs to be able "to coordinate his or her attention between an object and the adult (initiate eye contact), to map the adult's reaction to its source (follow gaze), and to comprehend the

communicative significance of the adult's emotionally valenced message" (Thurman & Mervis, 2013, p. 2).

Impairments in initiating eye contact, in following gaze and in interpreting emotional expressions have been often reported in studies of older children with ASD, but experimental or observational reports of social referencing in children with ASD have been scarce (Bacon, Fein, Morris, Waterhouse, & Allen, 1998; Cornew, Dobkins, Akshoomoff, McCleery, & Carver, 2012; DeQuinzio, Poulson, Townsend, & Taylor, 2016; Magrelli et al., 2013). Bacon et al. (1998) reported that 4- and 5-year-olds with ASD were less likely to seek information from an adult when confronted with a novel stimulus. In a study involving much younger infants (18 months) those at high risk for ASD who later received an autism diagnosis (HRI+) engaged in slower information seeking compared to both the TD infants and the HRI without a later ASD diagnosis (HRI−) suggesting that this aspect of referencing may be an early indicator of ASD (Cornew et al., 2012). At 18 months both of the HRI+ and HRI− groups showed difficulties in regulating their behavior based on the adults' emotional signals, when compared to the TD group. The authors' interpretation of the latter result was that this aspect of social referencing may reflect an endophenotype for ASD. However, deficits in regulating one's behavior based on the meaning of the adult's emotional signals were found in other groups of children with IDD, including children with WS (Thurman & Mervis, 2013), suggesting that this aspect of social referencing may be related to developmental delay instead of being specific to, or predictive of ASD.

Thurman and Mervis (2013) compared 3–4-year-old children with WS with age-matched children with DS in a social referencing paradigm, and also in three experimental studies designed to tap each of three component abilities (initiating eye contact, gaze following, and emotional responsivity) important for success in social referencing. The tasks designed to assess these abilities involved an experimenter producing ambiguous and unambiguous actions with a toy, turning her head with eyes opens and with eyes closed, and showing a joyful or fearful emotional reaction about an ambiguous stimulus, respectively. Findings indicated that in all these domains, contrary to expectations based on their social phenotype, the children with WS *showed less* advanced sociocommunicative competence *than the* children with DS. Specifically, Thurman and Mervis (2013) reported that the children with DS were more likely to initiate eye contact (unsolicited), to shift their attention between the adult and the stimulus, and to follow the adult's gaze in triadic situations than were children with WS, across conditions. The groups

showed some commonalities though in their responses to the adult's expressed emotion: for the joyful signal the majority of children in both groups demonstrated positive responses regarding the stimulus, but neither group regulated their behavior in response to the adult's expressions of fear. These results are surprising when considering that the WS group had significantly higher overall intellectual abilities and language scores than those of the children with DS, raising interesting questions about the origins and specificity of the sociocognitive and communicative impairments found in WS, as well as about the factors that may promote more advanced social engagement behaviors in children with lower cognitive functioning, such as those with DS.

4.2 Joint Attention and Imitation

Social referencing shares a number of characteristics with joint attention processes, in that both rely on taking into account another person's behavior (gaze and emotional reaction) toward an object or situation attended by the infant. Establishing joint attention involves attentional coordination in the form of triadic exchanges between the child, the interaction partner, and an outside object/referent, being thus "a step above" dyadic forms of interaction, such as social orienting, sharing affect, taking turns in a routine, or mimicry (Tomasello, 1992; Trevarthen, 2001). Establishing joint attention also provides opportunities for learning about the environment, and in particular is beneficial for acquiring words (Tomasello, 1988). Not surprisingly, deficits in joint attention have been widely documented in the interactions of children with ASD with caregivers, other adults, and peers.

One of the first studies to include infants meeting criteria for ASD on the CHAT at 20 months, focused on early emerging socioaffective and symbolic abilities (joint attention, imitation, empathy, and pretend play) evaluated in a series of experimental tasks (Charman et al., 1997). In this study, the infants with autism showed atypical behaviors in all areas assessed, with the exception of requesting behaviors, when compared to infants with IDD without autism. More specifically, they failed to use social gaze declaratively (to share attention referentially) in the joint attention task and were less likely to initiate joint attention, they showed poor emphatic response, fewer imitated modeled actions on objects, and none produced spontaneous pretend play. Subsequent studies using similar paradigms corroborated these findings (Dawson et al., 2004; Landa, 2007; for review, see Bruinsma, Koegel, &

Koegel, 2004). In a longitudinal study examining relations between joint attention, imitation, and play in a group of 20-month-old infants and their language and ToM abilities at 44 months, Charman, Campbell, and Edwards (1998) found that only joint attention measured at 20 months had a strong longitudinal association with ToM ability at 44 months, providing further evidence for the critical role played by this form of triadic sharing of attention in the development of complex social-cognitive abilities.

Toddlers with WS have also been shown to have an atypical pattern of social attention (Jones et al., 2000), marked by poor joint attention skills but intense and prolonged attention to the interaction partner, as reported in observational studies (Mervis et al., 2003) and assessed on measures of sociocommunicative abilities, such as the Early Social Communication Scales (ESCS; Mundy & Hogan, 1996). Laing et al. (2002) administered the ESCS to a group of toddlers with WS and a group of TD toddlers matched on developmental age. The toddlers with WS showed less object-related behaviors (declarative and instrumental pointing, reaching, and requesting toys) and more social interactive behaviors (requests for tickling, turn-taking behaviors, and eye contact not related to objects) than the control group. They used eye contact mostly in dyadic interactions, and less often for social referencing or combined with requesting or reaching behaviors than the controls, which suggests that for the toddlers with WS social interaction behaviors were less integrated with aspects of joint attention than for the TD toddlers (Laing et al., 2002). Similar findings have been reported by Hepburn, Fidler, Hahn, and Philofsky (2011), who compared, on a variety of measures including the ESCS, young children (2–5-year-olds) with WS to children with ASD matched on age and to a group of TD children matched on overall developmental age to both clinical groups. They found that the children with WS were no different from those with ASD in *initiating* joint attention, and both groups were significantly more impaired than the TD control, although the group with WS fared better than the ASD group in *responding to* joint attention (e.g., following proximal and distal point or gaze shift), behavior that reflects focusing on the partner, but may not necessarily lead to sharing attention about the referent of the partner's gaze or point in triadic interaction.

The almost exclusive focus of the WS toddlers on the interaction partner without sharing attention about objects and situations is likely to hinder their opportunities for learning about the world, including about people's goals, intentions, desires underlying behaviors, and may interfere with or delay the development of their ToM.

With the advancement of technologies that enabled researchers to capture eye movements and to record neural activity in very young infants, the research focus shifted toward more basic mechanisms that might lead to the atypicalities found in the sociocognitive abilities of toddlers with ASD or WS discussed above, by examining how infants allocate attention to various aspects of the environment, and how they respond to visual and auditory social stimuli. Jones and Klin (2013) found that infant siblings later diagnosed with ASD (HRI+) exhibited mean decline in eye fixation from 2 to 6 months of age, a pattern not observed in infants who did not develop ASD (HRI−). This decline appeared to mark "the early derailment of processes that would otherwise have a key role in canalizing typical social development" (Jones & Klin, 2013, p. 274). Similarly, Chawarska, Macari, and Shic (2013) found decreased spontaneous attention to social scenes in 6-month-old infants later diagnosed with ASD, as well as evidence for a later limited bias in attention for faces in toddlers with ASD (Chawarska, Volkmar, & Klin, 2010).

One of the recurring themes in the review of the experimental literature on precursors of sociocognitive abilities in ASD or in WS is that of atypical allocation of social attention, reflected in atypical gaze behavior toward social stimuli. Although the disruption in social attention appears to happen in opposite direction in ASD and in WS (e.g., for the visual domain, too little orienting and fixating on faces, in particular on eyes in ASD, whereas in WS—too much orienting and prolonged fixating on faces at the expense of learning about the nonsocial surroundings), it appears that the consequences for the development of sociocognitive abilities are somewhat similar: individuals from both clinical populations understand less about the social world than their age-matched unaffected peers. How is this possible? Computational modeling of the emergence of shared attention skills might provide some clues: Triesch, Teuscher, Deák, and Carlson (2006) proposed a computational model to simulate the emergence of gaze following skills in infant–caregiver interactions, and modeled how it fails in ASD and in WS. By manipulating the reward structure of the interaction (e.g., looking at caregiver made aversive or highly preferred), and/or delayed attention shifting behavior, which has been documented in both disorders, the model shows how both excessive (as in WS) and limited (as in ASD) interest in the caregiver's face should lead to deficits in gaze following skills, which are critical for the development of joint attention skills (Asada & Itakura, 2012). Such models have a heuristic value, potentially explaining how, for instance, social motivation may be driving behavior in different directions—toward

or away from social contact—yet may lead to similar difficulties in understanding the world of people, as is the case with ASD and WS.

Research is still far from having solved the puzzle of why the development of social cognition is derailed in many developmental disorders, but the surge of interest in this domain may soon lead the interdisciplinary efforts needed to understand the complex interactions between genes, environment, neurobiology, and behavior implicated in this process.

5. CAVEATS, TRENDS, AND DIRECTIONS FOR FUTURE RESEARCH INVESTIGATING SOCIAL COGNITION

In this chapter, we presented the most commonly used experimental tasks designed to probe various components of social cognition, and discussed recent findings from studies involving individuals with IDDs based on these behavioral paradigms. We chose to focus on two neurodevelopmental disorders that have been extensively studied over the last 3 decades, ASD and WS, because they present ostensively contrasting social–behavioral phenotypes, yet show intriguing similarities in sociocognitive phenotypes, which renders these disorders "model syndromes for investigating social cognitive and affective neuroscience" (Tager-Flusberg, Plesa Skwerer, & Joseph, 2006).

From this survey of recent research, it became clear that many contradictory findings have been reported for the same clinical population, often despite consistency in the methodology used across studies. Using the same or very similar tasks to probe well-defined aspects of social cognition enables meaningful cross-study and cross-syndrome comparisons that may help detect syndrome specificity in the abilities tested, and, ideally, provide replications of findings across studies. However, many of the studies described included participants from a relatively wide age range and did not take a developmental approach to task performance, shortcomings that may explain in part some of the inconsistencies in the reported findings.

In the majority of studies involving an ASD group, only "high-functioning" individuals were included to ensure comprehension of the instructions and compliance with task demands. This means that the majority of findings in research have been based on the performance, behavior, and neural activity of a subgroup of individuals with ASD, which may not be representative of the entire population affected by autisms (Dykens & Lense, 2011). An estimated 30% of individuals with ASD are minimally verbal or nonverbal, and this population has largely been left out of research

studies until very recently (Tager-Flusberg & Kasari, 2013). Similarly, because of the high anxiety and fears experienced by many individuals with WS, including fears of enclosed spaces, most of the studies involving brain imaging have been conducted with a select group of individuals with average IQ (Meyer-Lindenberg et al., 2005; Meyer-Lindenberg, Mervis, & Berman, 2006) who may not be representative of the WS population. Only recently have researchers succeeded in including a number of individuals with WS with mild-to-moderate IDD in neuroimaging studies (Haas & Reiss, 2012).

To date, no comprehensive explanatory framework has emerged that could reliably account for the combination of weaknesses and strengths demonstrated by individuals with neurodevelopmental disorders in social understanding and social functioning, as well as for the considerable heterogeneity in behavioral, physiological, neural profiles, and in the etiology of complex disorders. Below we outline some of the directions in which future research in social cognitive neuroscience may start to bridge this knowledge gap in our understanding of neurodevelopmental disorders.

5.1 Considering Within-Population/Syndrome Heterogeneity and Genetic Variation

A critical direction for future studies involves finding analytical approaches that enable researchers to take into consideration this substantial heterogeneity found within syndromes (Georgiades et al., 2013; McPartland & Pelphrey, 2012), which may be one source of inconsistencies in findings related to social cognition across studies. Taking into account individual differences in analyses may uncover subgroups of individuals within syndrome that show different patterns of reactivity influencing their behavioral performance and that could therefore cancel out relevant differences when comparing the syndrome-sample as a group to control groups. For instance studies have already shown that there may be subgroups among individuals with ASD with different psychophysiological profiles (e.g., hyperarousal and hypoarousal subgroups—Joseph et al., 2008), which may impact behavioral performance or visual scanning behavior. Several researchers have suggested that emotion processing in ASD, for instance, may be an area that would afford defining subgroups of individuals that are more homogenous (McPartland & Pelphrey, 2012; Pelphrey et al., 2011) and may reflect different etiological paths to ASD. This approach could become a basis for tailoring interventions to the specific needs of these subgroups (Xavier et al., 2015). Recent research has shown that this approach is relevant to genetic

studies, which are increasingly focusing on the possible links between molecular genetic variation and individual differences in behavioral and brain imaging findings in social cognition (Losh, Martin, Klusek, Hogan-Brown, & Sideris, 2012; Vieland, Hallmayer, Huang, et al., 2011).

5.2 Taking Into Account the Role of Environment/Individual Experiences and Ontogenetic Development

At the same time, there is a clear need for researchers to take into account the bidirectionality between genetic influences on neurodevelopment and the environment that contributes to shaping neurodevelomental outcomes through individual experiences (Haas & Reiss, 2012). Significantly less interest has been invested in relating genetic and experimental findings to the experiential circumstances of the participants with neurodevelopmental disorders (e.g., family situation, socioeconomic and cultural background, parenting style, quality of close relationships, and attachment). Some environmental factors have been explored in relation to children's sociocognitive development primarily in ASD, such as the potential influences of attachment relations, mostly on children's emotion processing (see for review, Rutgers, Bakermans-Kranenburg, van Ijzendoorn, & van Berckelaer-Onnes, 2004), or the role of parental language (Haebig, McDuffie, & Ellis Weismer, 2013; Siller & Sigman, 2002) and gesture use (Talbott, Nelson, & Tager-Flusberg, 2015) on children's developing communicative abilities. Other aspects of the family environment received less attention, and when studied, findings have been inconclusive. For instance, the two studies that have examined the role of siblings in the development of ToM abilities in children with ASD arrived at opposite conclusions, one finding a negative effect (O'Brien, Slaughter, & Peterson, 2011), the other indicating a positive influence on ToM development, as has been shown for TD children (Matthews, Goldberg, & Lukowski, 2013). Thus, there is a need for more complex designs that could take into account the joint influence of a variety of environmental factors on well-defined components of children's developing sociocognitive abilities instead of treating poorly operationalized aspects of the (family) environment as isolated influences. This requirement extends to taking into account the role of ontogenetic development, which cannot be adequately captured exclusively in cross-sectional designs that rely on group comparison, with all the shortcomings of group matching decisions (Jarrold & Brock, 2004). Given that longitudinal designs have practical drawbacks, being difficult to sustain over time when researching developmental disorders of rare incidence, an alternative approach that

has the potential to combine the advantages of both designs relies on tracing developmental trajectories of particular skills investigated in individuals with neurodevelopmental disorders and comparing them to normative trajectories. Although this approach has been used in many studies involving various neurodevelopmental disorders it has not been widely applied to the study of social cognition, except for explorations of face processing and language in WS (Karmiloff-Smith et al., 2004; Thomas et al., 2009).

5.3 Increasing the Ecological Validity of the Tasks and Stimuli

The real test of social cognition is social functioning. The majority of tasks currently used to investigate sociocognitive abilities is designed for administration in the lab under well-controlled conditions and have little resemblance to real-life social situations. As Ponnet, Roeyers, Buysse, De Clercq, and Van der Heyden (2004) comment "the use of static stimuli (such as tales, drawings, photographs and others) is hardly a naturalistic way to evaluate social understanding. (….) since individuals with autism experience difficulties with social interaction, investigators should attempt to measure their social functioning in contexts that mirror as closely as possible real-life social interactions" (p. 254). The use of film segments, especially to probe "advanced ToM" abilities (Dziobek et al., 2006; Golan et al., 2006; Heavey et al., 2000; Riby & Hancock, 2009a, 2009b) is one direction that many researchers have taken toward increasing the ecological validity of stimuli. However film-based stimuli have been usually presented in passive viewing tasks, a format that is a poor approximation of real-life interactions. Recently researchers have devised virtual reality-based tasks, which may come closer to providing the experience of real-life interactions, by approximating social contingency and some of the challenges that social environments present for people with ASD. For instance, Oberwelland et al. (2017) used an interactive gaze contingent task to study joint attention in adolescents with ASD, who were asked to either initiate or respond to gaze shifts when "interacting" with an avatar that depicted either a stranger, or the participant's mother. The virtually avatar's reaction (i.e., gaze behavior) was contingent upon the participant's gaze behavior (depending on the experimental condition), making it possible to investigate joint attention during real-time social interaction while participants' brain activity and visual behavior were recorded in an eye-tracking and fMRI paradigm. The authors found significant differences in the joint attention network in TD and ASD

adolescents at this late stage of development, demonstrating that "even very basic forms of gaze-based social interaction (without noticeable differences in behavioral performance) are associated with profound differences in the underlying neural bases" (p. 119). Such tasks, which may not "look" but may "feel" like a slice of real life to the participant who has to react to (or initiate) social overtures in real time, could provide useful alternatives to current experimental paradigms.

Moreover, settings involving virtual reality and "avatar assistants" (Hopkins et al., 2011; Kandalaft, Didehbani, Krawczyk, Allen, & Chapman, 2013) have been successfully used in interventions aimed at improving social skills in individuals with ASD as these may be a way of attenuating the high arousal that some people with ASD experience in real-life social situations. It is worth exploring whether such paradigms could also help attenuate the high fascination with live interaction partners shown by individuals with WS, and thus might provide a setting that would promote learning in the context of social skills interventions for individuals with WS.

5.4 Using Multiple Methods to Investigate Underpinnings of Behavioral Performance

Another direction of research that could help explain current contradictory findings and find syndromic subgroups of individuals is the combined use of multiple methods to detect and measure aspects of subject state (arousal, attention, and anxiety) that may interfere with, or mediate behavioral performance on social-cognitive tasks, as well as in real-life social interactions. The use of eye-tracking technology, sometimes in combination with brain imaging, has yielded some of the more relevant findings for understanding the role of basic processes (such as gaze following) in the social-cognitive impairments characteristic of ASD and of other developmental disorders. Measurements of arousal, or estimates of trait and state anxiety might help refine the interpretation of behavioral findings, especially on tasks involving social stimuli. For instance, by combining eye tracking during a face emotion recognition task with a measure of self-reported social anxiety (Corden, Chilvers, & Skuse, 2008), were able to discover a group of adults with ASD who were impaired in their recognition of fearful and sad expressions, spent significantly less time fixating the eye region of all faces, and showed a clear relation between fixation on the eyes, accuracy in recognizing fearful expressions and levels of social anxiety, relation that was not found for the controls matched for age, IQ, and visual–perceptual ability in that study.

Specifically, poor fear recognition and reduced fixation of the eyes were independently associated with greater levels of social anxiety in ASD individuals, a finding that underscores the importance of taking into consideration the multitude of factors, both internal, related to the individual's profile of reactivity and motivation, and external, related the task and context of assessment that influence observable behavior and performance levels.

Recently researchers have also started to investigate the potential role of hormones, in particular neuropeptides such as oxytocin and vasopressin in modulating social behavior and even social cognition (Francis et al., 2014; Guastella et al., 2010; Meyer-Lindenberg, 2008) adding the tools of neuroendocrinology to the repertoire of methods that could contribute to understanding the complex ways in which cognition and behavior relate to underlying genetic, neurochemical, neurobiological, and experiential processes over developmental time. For instance, recent studies have reported finding dysregulation of the oxytocin system both in autism (Gregory et al., 2009) and in WS (Dai et al., 2012; Haas et al., 2009), linked to syndrome-specific behavioral phenotypic outcomes. Although the processes by which these effects occur remain somewhat elusive, such findings could help narrow the gap between behavior, brain function, and genetic mechanisms, as our knowledge about the genetic and epigenetic regulation of such neurochemical systems evolves.

Ultimately, social cognition is embodied cognition. How people think about others is deeply rooted in the experiences that are afforded to the individual by the complex interplay between preexisting neurobiological structures (that may be altered by genetic events) and individual agency manifested in acting upon and forming representations of the surroundings (the physical and social environment). Human agency is guided by early preferences for certain features of the world that become particularly salient for the developing person, resulting in experiences that in turn may shape neurodevelopment along typical or atypical paths. The challenge researchers have yet to overcome is to approach the study of social-cognitive abilities from the totality of the human mind and body. If, as Klin et al. (2003) suggest may be the case for people with autism, "the topology of salience" that normally simplifies the vast complexity of the surrounding environment into aspects to pay attention to and aspects to ignore, is represented differently in those affected by ASD leading to different ways in which the child "enacts" the world (e.g., preferentially orients toward nonsocial stimuli), then the child's resulting experiences will differ from those "expected"

for typical neurodevelopment. In this view the child or adult with IDD is not just a person "diminished cognitively," but someone who experiences and represents the world differently altogether. Research has made great progress in finding ways to detect, record, and describe these fundamental differences, but a lot more work remains to be done to understand the causes leading to these differential "enactments" of the world. This understanding is critical for deciding when and how to intervene to help the child navigate a complex and confusing world with more ease and confidence.

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