Preface

Understanding Other Minds: What's new?

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As editors of *Understanding Other Minds* (3rd edn, henceforth *UOM-3*), we are proud to have compiled such an exciting set of new chapters, by such an internationally impressive set of scholars, addressing what some regard to be the central psychological process separating humans from all other animals: namely, the ability to imagine the thoughts and feelings of others, and to reflect on the contents of our own minds. This drive and capacity to attribute mental states to others has for 30 years gone under the rubric of possessing a "theory of mind" (ToM).

In *UOM-1* (1993) and *UOM-2* (2000), we brought together the state of the art in research into ToM during each decade, bringing together scientists and philosophers from fields as diverse as developmental psychology, psychiatry, and clinical psychology, neuroscience, primatology, and philosophy. The aim was to understand the nature of ToM by studying its development, its impairment, its brain basis, its evolution, and its theoretical baggage. For those volumes, we were joined by a third editor, Donald Cohen, who tragically passed away far too young, after a difficult battle with cancer, and who brought a psychiatrist's perspective to bear to this fundamental field.

The need for a new edition of this book comes about because the field has not stood still over the past decade—on the contrary, the field has continued to attract some of the best minds in the effort to understand our mind. So what's new in *UOM-3*? First, we have a new co-editor, Mike Lombardo, who is an example of how the field has blossomed via a new generation of talented young developmental social neuroscientists interested in ToM both from the standpoint of typical development and its atypical expression in conditions such as autism. Secondly, as our understanding of the biology underlying ToM has deepened, so has our understanding of its development, cross-cultural expression, and its atypical role in a variety of neurodevelopmental conditions. In this Preface we provide a brief summary of what a reader of *UOM-3* can expect, reflecting these new developments in the field.

Development

Victoria Southgate (Chapter 1), who opens this volume at the earliest stages of development, reveals how infancy research demonstrates that ToM is present much earlier than previously believed. She reviews exciting work from her own and other laboratories, suggesting that

infants expect others' behavior to be congruent with their own beliefs, even in the first two years of life. She argues that infants' performance on the tasks used to tap these abilities do not just reflect behavior-reading, but actually reflect mindreading, even at this young age. Andrew Meltzoff and Alison Gopnik (Chapter 2) review training studies suggesting that a ToM "module" does not just "turn on" in the child, but that development is influenced by experience, evidence, and learning. Furthermore, they argue that the child's initial state contains Bayesian "priors" that constrain learning, one example being the principle that other minds are "like-me". They describe elegant new experiments with young children to support their ideas, for example, from understanding other people's visual perspectives, and conclude that children's ToM is plastic enough to accommodate to the specific culture in which they find themselves.

Johannes Roessler and Josef Perner (Chapter 3) address a classic question from ToM research (why 3-year-olds typically fail false belief (FB) tasks), by arguing that 3-year-olds are "teleologists". By dissecting what young children think other's "ought" to do in a situation, Roessler and Perner offer an explanation for why young children's explicit ToM (where they make errors) is at odds with their own implicit ToM (which, as Southgate shows, they already possess).

Ian Apperly (Chapter 5) reminds us that ToM development doesn't stop in childhood, and that by studying ToM in adults we see that some forms of ToM require effort, whilst others are effortless and even automatic. He makes a claim for the existence of two systems, and links this to the infancy work and to the neural basis of ToM. Later in this volume, Alvin Goldman and Lucy Jordan (Chapter 25), from their perspective as philosophers, update the cognitive debate between "simulation theory" and "theory theory" as mechanisms underlying the development of a ToM.

Cross-cultural perspectives

Henry Wellman and Candida Peterson (Chapter 4) provide a striking graph showing that across eight different cultures, the same transition is seen between approximately 3- and 4-year-olds (with some cultural variation in ages, but not in trajectory) in passing FB tests. They also report their efforts to create a ToM scale that can be used not only across cultures, but also across medical conditions, and describe their investigations into how ToM develops differently and later in those deprived of hearing spoken language (deaf children). Their results sit comfortably with Meltzoff and Gopnik's conclusions that the nature of the input a child receives affects the way in which ToM develops. Liane Young and Adam Waytz (Chapter 6) go one step further, to explore the interesting claim that we use our ToM most when we make moral judgments. David Kenny (Chapter 7) guides us through the array of standardized measures that exist to study "judgment accuracy", a factor within "emotional intelligence", which overlaps with ToM, reminding us of the importance of psychometric issues in how we measure ToM.

Electrophysiology and functional neuroimaging

Mark Sabbagh (Chapter 8) picks up the theme of the neural basis of ToM by discussing encephalographic recordings (EEG)/event-related potential (ERP), making a claim for the N270 playing a key role, and discussing mu-suppression during both intentional action and perception of intentional action. Jorie Koster-Hale and Rebecca Saxe (Chapter 9) give us a tour of the functional magnetic resonance imaging (fMRI) literature on ToM, reminding us that, whereas in *UOM-2* only four studies were reviewed, today there are over 400! Right temporo-parietal junction (RTPJ) and ventromedial prefrontal cortex (vMPFC) are, they argue, well-replicated

ToM regions and "one of the most remarkable scientific contributions of human neuroimaging, and the one least foreshadowed by a century of animal neuroscience". These regions, they argue, do not work in isolation, but are part of a network. Despite the widely differing experimental paradigms different investigators have employed, consistently similar brain regions are activated.

Neurological lesion studies

Dana Samson and Caroline Michel (Chapter 10) update our knowledge about ToM from studies of brain damage. They describe patient WBA who, following a stroke and acquired damage to his right lateral prefrontal cortex, suffers from an inability to set aside his own perspective. A second patient, PH, following a left-hemisphere stroke, suffered from an inability to process grammar, but his ability to pass false belief tasks remained unaffected. They argue that this suggests that once ToM is established, syntactic ability plays a minor—if any—role. A third patient, CM, with semantic dementia and atrophy of the left temporal pole, struggled to understand mental state words, but had no difficulty understanding others' intentions on non-verbal tasks. These valuable "natural experiments" enable "fine cuts" in the neuropsychology of ToM.

The neural basis of empathy

Anat Perry and Simone Shamay-Tsoory (Chapter 11) extend this approach to the study of empathy, fractionating it into "emotional" and "cognitive" empathy, making a case from both lesion and fMRI studies for inferior frontal gyrus (IFG) being central to emotional empathy, anterior cingulate cortex (ACC) and insula being central to pain perception, with each of these linking to the amygdala. In contrast, they present the evidence for cognitive empathy being a circuit comprising TPJ, superior temporal sulcus (STS), vmPFC/orbito-frontal cortex (OFC), dorsolateral (dlPFC) and dorsomedial prefrontal cortex (dmPFC). They also look at evidence from fMRI studies to show how these regions overlap and differ in neuropsychiatric conditions, such as autism, schizophrenia, and psychopathy, and how the two components of empathy are both independent and yet interact.

Cade McCall and Tania Singer (Chapter 12) also consider the brain bases of empathy, delineating the "pain matrix" through experiments. An example is where the observer sees a Q-tip stroking a hand or a needle puncturing a hand, which gave rise to the discovery that parts of this "matrix" are active when we experience pain and when we observe another person in pain, validating a "mirror system". Jamil Zaki and Kevin Ochsner (Chapter 13) pick out an Experience Sharing System (ESS), distinct from a Mental State Attribution System (MSAS), as what they call a "tale of two systems". This converges on the emotional vs. cognitive empathy systems delineated by Perry and Shamay-Tsoory.

The mirror neuron system

Christian Keysers, Marc Thioux, and Valeria Gazzola (Chapter 14) provide a review of the mirror neuron system (MNS) in social cognition, in both monkeys and its putative equivalent in humans. They argue for this being a building block of major human abilities, from imitation to language. Giacomo Rizzolatti and Maddalena Fabri-Destro (Chapter 15) provide their own first-hand perspective on the discovery of the MNS in the monkey brain, and their view of how the human MNS is dysfunctional in autism.

Oxytocin

Markus Heinrichs, Frances Chen, and Gregor Domes (Chapter 16) report on the latest research into the role of the peptide hormone oxytocin (OXT) in our capacity for empathy and social cognition. They argue that OXT increases social approach by reducing social stress reactivity (evidence of lower cortisol during OXT administration), and boosting social motivation. They argue that the amygdala is the target for OXT. Amygdala volume and activation during emotion processing are also correlated with polymorphisms in the oxytocin receptor gene (*OXTR*) and OXT dampens amygdala stress responses. OXT also increases interpersonal trust as well as attachment, and *OXTR* variations are associated with maternal sensitivity to their child's needs. OXT also boosts performance on ToM/emotional accuracy tests, and increase amount of gaze to the eye region of the face. This paints an important picture of how OXT sets the stage for focusing on another's mental states, and for learning to use a ToM. The authors explore the potential of OXT for therapy for conditions involving social anxiety and deficits in social cognition.

Prenatal testosterone

Bonnie Auyeung and Simon Baron-Cohen (Chapter 17) review work indicating that fetal testosterone (FT) is inversely associated with a range of indicators of social development, such as eye contact, language development, mentalizing, and empathy. They also report on a recent study by Mike Lombardo and colleagues showing that FT is associated with increased gray matter volume of the RTPJ, a key mentalizing brain region. They argue these effects are specific to the prenatal effects of testosterone, and report positive associations between FT levels and the number of autistic traits found later in development. However, they also review evidence that administration of testosterone in adulthood changes activation levels of a number of brain regions relevant to ToM and emotion processing, such as orbitofrontal cortex (OFC) and amygdala, as well as reward circuitry, such as the ventral striatum. They argue that testosterone may have "opposite" effects to oxytocin.

Genetics

Bhismadev Chakrabarti and Simon Baron-Cohen (Chapter 18) discuss the heritability of empathy using evidence from twin studies. They also discuss different approaches to identifying the genetic basis of autism, in which ToM is impaired. These approaches include genome-wide association studies, copy number variations, and candidate single nucleotide polymorphisms (SNPs). They adopt the latter approach by studying SNPs in genes involved in neural growth and connectivity, or in social and emotional responsivity, and in sex steroid hormones. Genes associated with empathy included *NTRK1* and *NTRK3*, *ESR2*, *GABRB3*, and *OXTR* among others. They make a case for taking a systems-based approach to understanding the function of genes that might relate to empathy and ToM.

Deaf children

Jennie Pyers and Peter de Villiers (Chapter 19) summarize the development of ToM in deaf children raised by signing parents (so-called deaf children born to deaf parents (DoD)) vs. deaf children born to hearing parents (DoH) and who are orally taught, to tease out the role of language in the development of ToM. They report how deafness per se does not impact ToM development since deaf children brought up as native signers perform as well as typically

hearing children. However, deaf children brought up by hearing parents show language delay and subsequent delay in the development of ToM. This clearly illustrates the role that language plays in ToM development. Other studies reveal the complex interplay between language and ToM in the deaf, and connect with Wellman and Peterson's earlier chapter dealing with this question. They explore the important question about the role of establishing joint attention in children who are deaf, and whether this is a critical mediating factor in whether ToM proceeds typically or not.

Psychopaths

James Blair and Stuart White (Chapter 20) remind us that, of all clinical groups, those with anti-social personality disorder, a subset of whom would meet criteria for psychopathy, are the clearest case of a group who lack emotional empathy, despite having excellent cognitive empathy and ToM. They can manipulate and even torture a victim by knowing very well what their victims thoughts and feelings are, but don't have the typical emotional responses to another person's suffering. They describe their "integrated emotions systems" model of how a typical child learns morality, the key role of the amygdala, insula, and inferior frontal cortex (IFC) in this process, because these brain regions are critical for forming associations with negative emotions, such as fear, disgust, and anger; and the role of the vMPFC in moral decision-making. The pattern of empathy deficits in psychopaths makes them a kind of mirror-image of those with autism, who struggle with cognitive empathy but may have intact emotional empathy.

Autism

Antonia Hamilton and Lauren Marsh (Chapter 21) devote their chapter to ToM in autism, hinted at frequently in other chapters in this volume, but central to this one. They focus on the mirror system in typical ToM, particularly the IFG and the anterior intraparietal sulcus (aIPS) in decoding others' actions. They contrast this with the brain's mentalizing system, particularly TPJ and mPFC. They explore the evidence for each of these two theories: the "broken mirror" theory vs. the impaired mentalizing theory of autism. Although early work found evidence supportive of the "broken mirror" theory, subsequent studies have found no differences during observation and imitation of other's actions. Studies from Hamilton's laboratory contrast atypical mentalizing system activity in autism, particularly in the mPFC, to intact mirror system engagement.

Peter and Jessica Hobson (Chapter 22) tackle the slippery concept of "self" in autism, reviewing studies of self-awareness, self-conscious emotions (particularly guilt and embarrassment), and reflection on one's own mental states, use of the first-person pronoun, and the self-reference effect in memory, all of which point to difficulties in the development of a concept of self and the self-monitoring function in autism. They review evidence from fMRI studies consistent with the view that in autism the self is atypical. Peter Carruthers (Chapter 26) provides a philosopher's perspective on self- vs. other-directed use of ToM. Julie Hadwin and Hanna Kovshoff (Chapter 23) usefully review teaching methods and interventions targeting ToM deficits in autism. These methods range from didactic approaches to breaking down ToM into principles, through to facilitating joint attention as a precursor to ToM, through to autism-friendly methods of teaching emotion recognition. These chapters are important in linking the nature of autism to clinical and educational

Non-human primates

Andrew Whiten (Chapter 24) reminds us that whilst humans are "inveterate mentalists", our "baroque human mental interpenetration is unparalleled in its complexity and depth". His chapter demonstrates that non-human primates have some elementary aspects of ToM, and argues that to understand this remarkable human achievement, we need an evolutionary framework. He reminds us that agriculture is only 10 000 years old, and that the evolutionary landscape to which we adapted was a hunter-gatherer lifestyle with a home base. Whiten reminds us that this niche was uniquely human—no other ape developed it. He retells the standard story of how, following the loss of forest cover in Africa, humans had to adapt by becoming bipedal and venturing out into the open savannah, having to outwit dangerous predators and become big-game hunters. Apes, in contrast, stayed in the forest. Humans alone had to develop the intelligence of using weapons and traps (requiring deception and ToM) instead of teeth and claws.

Whiten disputes the standard story as overlooking key factors in human evolution from studies of modern-day hunter-gatherers. This hints that our human ancestors probably lived in communities that were egalitarian and cooperative; how the base-camp likely involved information-sharing and a division of labour between the sexes; how hunting is akin to being a group-predator, rather than an individual predator; how hunter-gatherers developed culture and language; and how ToM fits into this "socio-cognitive niche". He also reviews the primate ToM literature over 30 years since Premack and Woodruff asked if the chimpanzee has a ToM, concluding (with Tomasello and Call) that chimpanzees may understand goals, intentions, perceptions, and even the knowledge states of others, but that they do not understand other's beliefs. This was the Rubicon that humans alone crossed.

These 26 chapters represent, for us as editors, a wonderful overview of a field that is as exciting today as it was when we published *UOM-1* in 1993. We thank our contributors and look forward to meeting them as authors and you as readers again, in *UOM-4*!