



# Imagination in human social cognition, autism, and psychotic-affective conditions



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## ABSTRACT

Complex human social cognition has evolved in concert with risks for psychiatric disorders. Recently, autism and psychotic-affective conditions (mainly schizophrenia, bipolar disorder, and depression) have been posited as psychological ‘opposites’ with regard to social-cognitive phenotypes. Imagination, considered as ‘forming new ideas, mental images, or concepts’, represents a central facet of human social evolution and cognition. Previous studies have documented reduced imagination in autism, and increased imagination in association with psychotic-affective conditions, yet these sets of findings have yet to be considered together, or evaluated in the context of the diametric model. We first review studies of the components, manifestations, and neural correlates of imagination in autism and psychotic-affective conditions. Next, we use data on dimensional autism in healthy populations to test the hypotheses that: (1) imagination represents the facet of autism that best accounts for its strongly male-biased sex ratio, and (2) higher genetic risk of schizophrenia is associated with higher imagination, in accordance with the predictions of the diametric model. The first hypothesis was supported by a systematic review and meta-analysis showing that Imagination exhibits the strongest male bias of all Autism Quotient (AQ) subscales, in non-clinical populations. The second hypothesis was supported, for males, by associations between schizophrenia genetic risk scores, derived from a set of single-nucleotide polymorphisms, and the AQ Imagination subscale. Considered together, these findings indicate that imagination, especially social imagination as embodied in the default mode human brain network, mediates risk and diametric dimensional phenotypes of autism and psychotic-affective conditions.

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*‘Autism means a withdrawal into fantasy but this is not what happens in the syndrome of autism. The schizophrenic may retreat from reality into fantasy, but the autistic child does not retreat, rather he fails to develop social relationships—a crucial distinction. Furthermore, so far as one can tell, the young autistic child has a deficiency of fantasy rather than an excess.’*

[Sir Michael Rutter, 1972, p. 327]

## 1. Introduction

Psychiatric conditions provide unique insights into the evolution, adaptive significance and genetic underpinnings of human

cognition and behavior because they reflect specifiable perturbations to normally developing and functioning neurological systems (Crespi & Leach, 2015). Disorders that involve human social and self-reflexive cognition, and human imagination and creativity, are of particular interest, given that evolution along the human lineage has involved selective expansion and elaboration of the regions of higher-order association cortex subserving these functions (Buckner & Krienen, 2013; Rakic, 2009; Saxe, 2006). How, then, might social and imaginative cognition be associated with psychiatric disorders?

Two sets of disorders, the autism spectrum and the psychotic-affective spectrum, most centrally, across all psychiatric conditions, involve alterations to human sociality and imagination. The autism spectrum historically includes autism and Asperger syndrome; it usually presents from early childhood with some combination of social and communication deficits plus the presence of restricted interests and repetitive behavior (Lord & Bishop, 2015). By contrast, psychotic-affective conditions include schizophrenia, schizotypal personality disorder, bipolar disorder, depression,

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borderline personality disorder, and dissociative disorders (and some related conditions), all of which overlap broadly in their symptoms and correlates, which may include, among other signs, some combination of psychosis (reality distortion), overly negative or positive (and dysregulated) mood, and dissociation (reduced integration of cognitive functions with regard to self, surroundings, memory and perception) (Balaratnasingam & Janca, 2015; Moskowitz & Heim, 2011). These disorders most commonly exhibit onset in adolescence or young adulthood, such that childhood development is completed relatively normally, although it is more likely than usual to have involved adverse social-environmental circumstances.

Kanner (1943) described nonsocial, repetitive and non-symbolic play as being central features of autistic behavior among his cohort of study children. Reductions and alterations to pretend play in autism are interesting because they span its two major dimensions, sociality and repetitive activities, whose association may otherwise remain unclear. Moreover, reduced imagination represents an important criterion for autism diagnosis (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Lord, Leventhal, & Cook, 2001; Rutter, Le Couteur, & Lord, 2003), and pretend play, and its generalization in ongoing development of the imagination (Vygotsky, 2004), represent fundamental aspects of human childhood. As such, decreases and changes to imagination hold promise as potentially-foundational aspects of autism, that may help to explain its diverse manifestations, correlates and causes, as well as directing attention to effective therapies (e.g., Woodard, Chung, & Korn, 2014; Woodard & Van Reet, 2011).

What is especially striking about alterations to imagination, in the context of its reductions in autism, is that in psychotic-affective conditions, aspects of imagination are not reduced but, instead, tend to be increased (reviews in Burns, 2007; Jamison, 1993; Kaufman, 2014; Kyaga, 2014; Nettle, 2001). Such positive associations of imagination with psychotic-affective conditions have been particularly well-documented with regard to schizophrenia, schizotypy, bipolar disorder, and depression, where individuals with milder forms and symptoms of these conditions, and close relatives of individuals with such disorders, consistently exhibit evidence of higher levels of creativity, divergent thinking, and imaginative cognition, as evidenced by diverse lines of information (e.g., Jamison, 1993; Kyaga et al., 2013; Nettle, 2001; Rutter & Johnson, 2015; Zabelina, O'Leary, Pornpattananangkul, Nusslock, & Beeman, 2015). How, then, is imagination related to the psychological dysfunctions typical of these conditions, and what can the study of imagination tell us about the similarities and differences between autism spectrum conditions and psychotic-affective conditions (especially schizophrenia), a topic of recent increasing interest (e.g., Ciaramidaro et al., 2015; Currie, 2000; Dinsdale, Hurd, Wakabayashi, Elliot, & Crespi, 2013; Hommer & Swedo, 2015)? A primary hypothesis that we address in this context is that autism spectrum conditions, and psychotic-affective conditions, can be regarded as psychological 'opposites' to one another with regard to expressions and correlates of imagination. This hypothesis was developed by Jung (2014), who described how autism is characterized by deductive, explicit and convergent thinking that favors intelligence-mediated solving of useful problems, whereas psychosis involves abstracted, metaphorical, and divergent thinking, that mediates implicit, novel and creativity-mediated problem resolution.

In this paper we first present a simple, useful definition of imagination, and describe how it is instantiated in neurological systems. Second, we provide an overview of the extensive literatures on imagination in autism, and in psychotic-affective conditions, to evaluate the hypothesis that autism spectrum conditions and psychotic-affective conditions represent diametric (opposite) disorders (Crespi & Badcock, 2008; Jung, 2014) with regard to this

core feature of human cognition. Third, we evaluate central aspects of this hypothesis using two lines of evidence: (1) data on dimensional measures of autism in healthy populations (the Autism Spectrum Quotient; Baron-Cohen et al., 2001), to evaluate gender biases in its Imagination subscale compared to other subscales, and (2) data on schizophrenia genetic risk derived from single nucleotide polymorphisms, to test for an association between genetic risk scores and imagination as quantified by the Autism Spectrum Quotient.

### 1.1. Imagination and its neural instantiations

The term 'imagination' is considered here as 'the faculty or action of forming new ideas, or images or concepts of external objects not present to the senses, typically derived from creative integration of past experiences, learning, or other information' (adapted from the New Oxford American Dictionary, Jewell & Abate, 2001, page 848). Imagination is conceptually most-closely related to creativity, generativity, divergent thinking, narrative production, and theory of mind, as well as to pretend play in children (Fig. 1). Production of novelty through imagination thus takes place through deriving elements of verbal or visual thought from perception and memory and combining them in new ways. Creativity can be distinguished from imagination in that it requires usefulness of the creative construct, as well as originality. Thus, for example, Stein (1953, page 311) defined a creative achievement as "a novel work that is accepted as tenable or useful or satisfying by a group in some point in time". It is important to distinguish carefully between imagination and creativity because their neural bases and psychological correlates are expected to differ to some as yet unknown degree.

Imagination can involve thinking in words and inner speech, and their condensed semiotic mental forms (Vygotsky, 2012), or thinking in pictures that are more or less reality-based (Pearson, Deeprose, Wallace-Hadrill, Heyes, & Holmes, 2013). Thinking in words, and thinking in pictures, appear to be inversely associated with one another, at least during episodes of 'mind wandering' (Stawarczyk, Cassol, & D'Argembeau, 2013). Imagination commonly exhibits self-oriented, social, and emotional content, whereby possible future scenarios are played out in the mind, or past events are processed for potential current and future salience (Schacter et al., 2012). In this regard, episodic memory and future thinking are closely associated with one another, as future mental

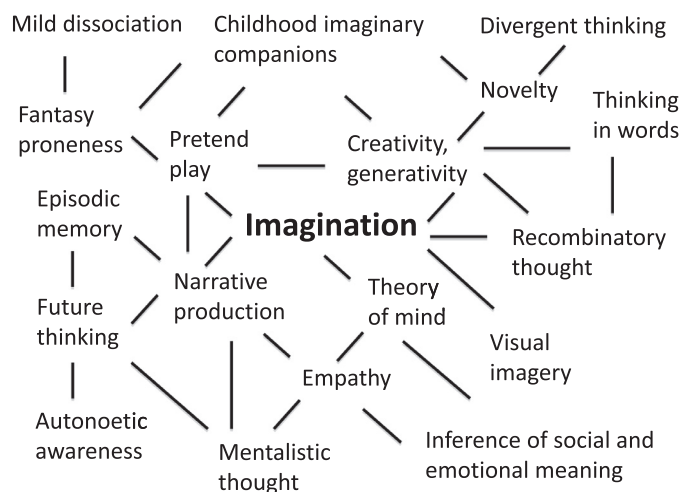


Fig. 1. Imagination, in neurotypical cognition, can be conceptualized in terms of a set of related phenomena that relate to core functions of the human brain.

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