



Discriminating autism spectrum disorders from schizophrenia by investigation of mental state attribution on an on-line mentalizing task: A review and meta-analysis

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ABSTRACT

In recent years, theories of how humans form a “theory of mind” of others (“mentalizing”) have increasingly been called upon to explain impairments in social interaction in mental disorders, such as autism spectrum disorders (ASD) and schizophrenia. However, it remains unclear whether tasks that assess impairments in mentalizing can also contribute to determining differential deficits across disorders, which may be important for early identification and treatment. Paradigms that challenge mentalizing abilities in an on-line, real-life fashion have been considered helpful in detecting disease-specific deficits. In this review, we are therefore summarizing results of studies that assess the attribution of mental states using an animated triangles task. Behavioral as well as brain imaging studies in ASD and schizophrenia have been taken into account. While for neuroimaging methods, data are sparse and investigation methods inconsistent, we performed a meta-analysis of behavioral data to directly investigate performance deficits across disorders. Here, more impaired abilities in the appropriate description of interactions were found in ASD patients than in patients with schizophrenia. Moreover, an analysis of first-episode (FES) versus longer lasting (LLS) schizophrenia showed that usage of mental state terms was reduced in the LLS group. In our review and meta-analysis, we identified performance differences between ASD and schizophrenia that seem helpful in targeting differential deficits, taking into account different stages of schizophrenia. However, to tackle the deficits in more detail, studies are needed that directly compare patients with ASD and schizophrenia using behavioral or neuroimaging methods with more standardized task versions.

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1. Introduction

The concept of having a “theory of mind” (ToM), i.e. the ability to explain one's own and the actions of others in terms of beliefs, desires and goals (“mentalizing”) (Blakemore et al., 2003), has been made use of in recent years to account for the development of certain symptomatology in mental disorders. Empathy (Blair, 2005) and mentalizing (Chung et al., 2014) deficits have repeatedly been described in autism spectrum disorders (ASD) and have been identified as core features to explain a lack of reciprocity (Kleinman et al., 2001). In schizophrenia, prominent psychotic symptoms, such as paranoid delusions, ideas of reference (e.g. Frith, 2004) and autistic features (Koelkebeck et al., 2010; Lugnegard et al., 2014), have been directly linked to a lack of ability to mentalize. A solid body of research has shown that patients with ASD (e.g. Frith, 1996) and schizophrenia (e.g. Brüne, 2005) have

dysfunctional ToM abilities, which can discriminate these patients from other mental disorders (Murphy, 2006).

Moreover, these two neurodevelopmental disorders, i.e. ASD and schizophrenia, share abnormalities in neural systems that have been identified to form the cerebral “mentalizing network” (Voellm et al., 2006). Within this network, brain regions (such as the medial prefrontal cortex (mPFC) and the superior temporal sulcus (STS)) have been shown to be abnormally activated (Bliksted et al., 2014; Brüne et al., 2008; Castelli et al., 2002; Pedersen et al., 2012) and structurally altered in the disorders (Benedetti et al., 2009; Brieber et al., 2007; Hirao et al., 2008; Koelkebeck et al., 2013; Waiter et al., 2004). In addition, changes in functional and/or structural connectivity have been reported in both patient populations (Das et al., 2012a; Eack et al., 2013; Li et al., 2014). However, it is not yet clear whether abnormal performance on and neural activation to ToM tasks could identify differential deficits (see e.g. Bora et al. (2009) for an account of the specificity of ToM deficits in schizophrenia and bipolar disorder and Chung et al. (2014) for a meta-analysis of findings on different mentalizing tasks in ASD and schizophrenia).

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As regards the validity of tasks that assess ToM deficits, it has been agreed that some tasks that are valid in children or severely compromised patients with ASD do not sufficiently target subtler deficits in adults with high-functioning ASD (Abell et al., 2000; Mathersul et al., 2013). It has been shown that ASD patients with higher functional levels pass false-belief tasks more easily than those with stronger autistic traits (Abell et al., 2000; Castelli et al., 2002). Similar assumptions hold true for patients with schizophrenia (Horan et al., 2009).

A task that provokes mental state attribution through interacting geometrical shapes may be particularly useful to detect deficits in ToM performance in high-functioning ASD patients and patients with schizophrenia. This task, here referred to as the “animated triangles task”, requires an on-line interpretation of social information, providing the task with properties close to real-life, and demands both implicit (earlier, spontaneous and related to biological motion identification) and explicit (reasoning about the mental states of others) mentalizing abilities (Koelkebeck et al., 2013; Wolf et al., 2010). The task consists of a set of short animated movies that depict two triangles. The triangles either move randomly, not interacting (e.g. bouncing off the walls; random movement (RAN)), interact in a goal-directed manner (e.g. fighting; goal-directed movement (GD)), or interact as if they read each other's minds (e.g. by mocking the other; ToM). After watching each movie, participants are asked to interpret the sequences freely. The answers are scored by criteria that subsume three dimensions: intentionality (usage of mental state terms), appropriateness of descriptions and length of answers (Abell et al., 2000; Castelli et al., 2000, 2002). One study (White et al., 2011) used a multiple-choice scoring system. Among these dimensions, the intentionality score in particular is regarded as crucial because of its capacity to reflect the mentalizing ability of a subject.

In this summary, we are reviewing studies that utilized the animated triangles task, either by behavioral or by brain imaging methods, in patients with ASD and schizophrenia. Moreover, we conducted a meta-analysis of behavioral performance data. For neuroimaging data, we were not able to calculate meaningful analyses due to the scarcity of comparable data sets. We think that the animated triangles task merits specific attention due to its unique properties as a non-verbal on-line mentalizing task. It is also part of the battery of social cognition

tests used in the Human Connectome Project (Barch et al., 2013; Hillebrandt et al., 2014; <http://www.humanconnectomeproject.org/>; last access to the HP: 22.12.2015). We aimed at resolving the following questions: 1) Are there consistent deficits in patients with ASD and schizophrenia that underscore the usefulness of the task? 2) Can distinct deficits in one or both of the patient groups be identified? 3) Are there research gaps that need to be accounted for in future research which might contribute to solving these questions?

2. Methods

2.1. Data sources and literature search

A systematic free text search was performed in PubMed, PsychINFO and EMBASE up to February 2015 using the words “animated triangles” AND/OR “moving shapes” starting from the first publication of the study details in 2000. Another free text search strategy using the following words: “Theory of mind” OR “mentalizing” AND “moving” OR “animated” AND “shapes” OR “triangles” as well as “theory of mind” OR “mentalizing” AND “videos” OR “animations” was also performed. The reference lists of all included articles were searched for additional publications and research groups that have published in the field were contacted for supplementary data. Articles written in English and published in peer-reviewed journals were included. Moreover, articles under submission and unpublished data the authors had notice of at the time of submission of this manuscript were included. All included studies were case-control studies. Single-case studies were excluded. In total, 51 studies using the animated triangles task were identified (see Fig. 1 for a flow diagram regarding the inclusion/exclusion of studies). The studies comprised investigations of healthy controls as well as clinical samples, using a broad methodology ranging from behavioral over neuroimaging to eye-tracking methods. Eleven studies of patients with ASD and ten studies of patients with schizophrenia as primary diagnosis were found (for a list of all studies see Supplementary material). In order to avoid duplicate study selection, all articles were evaluated and data extracted by the three authors. In cases of disagreement, the authors discussed the matter until consensus was achieved.

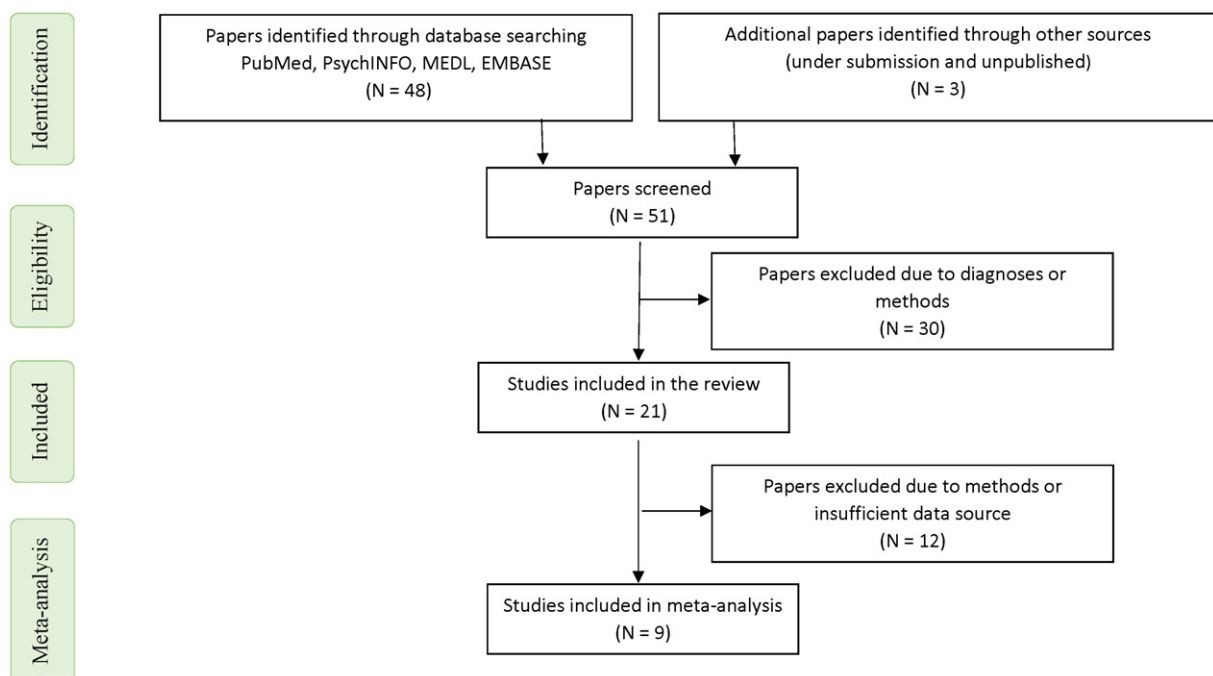


Fig. 1. Flow diagram illustrating the search strategy and inclusion/exclusion criteria used in the meta-analysis.

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