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Biological motion processing in schizophrenia – Systematic review and meta-analysis

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ABSTRACT

Context: Patients with schizophrenia show impairments in processing of biological motion. This is especially important since deficits in domains of social cognition has been associated with functional outcome and everyday functioning in this population.
Objectives: We conducted a systematic review and meta-analysis of studies which have used point-light displays to present whole-body motion to patients with schizophrenia and healthy controls, to evaluate the magnitude of differences between these groups in biological motion processing.
Method: Firstly, relevant publications were identified by a systematic search of Google Scholar and PubMed databases. Secondly, we excluded non-relevant studies for the meta-analysis according to our exclusion criteria. Effect sizes were expressed as standardized mean difference (SMD).
Results: 15 papers reporting results of 14 different experiments with 571 patients and 482 controls were included in the meta-analysis. The results for the general biological motion perception analysis revealed that patients with schizophrenia (compared with healthy controls) present reduced biological motion processing capacity with the effect size (SMD) of 0.66 (95% CI, −0.79 to −0.54; $p < 0.001$). The results for the specific biological motion-based tasks were also statistically significant with SMD of 0.72 for Basic Biological Motion task (95% CI: −0.94 to −0.51; $p < 0.001$) and SMD of 0.61 for Emotion in Biological Motion task, (95% CI: −0.79 to −0.43; $p < 0.001$) respectively.
Conclusion: The findings from our meta-analysis highlight abnormalities in general and specific domains of biological motion perception in schizophrenia patients as compared with healthy controls.

1. Introduction

Processing of biological motion is one of the most basic abilities in a repertoire of human social cognitive skills. It has been emphasized, that recognition of visual biological motion is of equal importance as information coming from evolutionarily younger channels (namely face and speech perception) while inferring the identity and social role of the other person ("social perception") (Troje, 2013). Since the point-light methodology was first introduced by the Swedish psychologist Gunnar Johansson (1973), numerous studies have confirmed that healthy individuals can easily detect the actions of other human agents and extract multiple characteristics of the presented person, even if the display of the agent has been reduced to a few point-lights attached to the major joints of the human body ("point-light walker"; PLW).·Preference for biological motion compared to non-biological motion and for more natural upright compared to upside-down displays of a PLW may be observed as early as in two-day old newborns (Simion et al., 2008). Furthermore, a fine tuning of the human visual system to process biological motion may be attributed to the specialized visual processing system for that type of stimuli, which encompasses superior temporal and frontal premotor areas and for which evidence was accumulated with lesion (Saygin, 2007), neuroimaging (Grosbras et al., 2012) and brain stimulation studies (Grossman et al., 2005).

Social cognitive deficits have become one of the primary focuses in schizophrenia research. This is due to a plethora of research linking domains of social cognition with functional outcome and everyday functioning of patients with schizophrenia (Fett et al., 2011). The significance of social cognitive deficits observed in patients has also been underlined by inclusion of social cognitive domains in MATRICS (Nuechterlein et al., 2008) and CNTRICS (Carter et al., 2009) initiatives, which aimed to provide standards for examination of cognitive deficits in patients with schizophrenia. Despite a great amount of attention being directed towards social cognitive deficits in schizophrenia (SCZ), no comprehensive meta-analysis of biological motion processing abilities in patients has been performed yet. This is surprising considering that biological motion is recognized as one of the two most prominent techniques to study processes associated with identification of social stimuli and their emotional value (Billeke and Aboitiz, 2013). Moreover, biological motion processing abilities are perceived as one of the main

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hallmarks of social cognitive deficits in neurodevelopmental disorders (Pavlova, 2012). The potential for further development of biological motion tasks to study social cognitive and affective domains was discussed by the CNTRICS initiative (Carter et al., 2009) and examined by the multicenter NIMH-sponsored Social Cognition and Functioning in Schizophrenia study (SCAF; Green et al., 2013).

At the same time, no measure associated with a recognition of social information from whole-body motion was included in a meta-analysis of quantitative studies examining social cognitive domains in patients with schizophrenia (Savla et al., 2012). Moreover, some of the studies which have been included in the meta-analysis had reported the results on tasks examining biological motion processing in patients (Bigelow et al., 2006; Couture et al., 2010; Kern et al., 2013). Yet only social cognitive measures that were not based on PLWs were extracted for the meta-analytic proceedings by Savla et al. (2012). Thus, the average magnitude of differences that can be found between patients with schizophrenia and healthy individuals with respect to biological motion processing abilities has not been examined yet. This paper aims to fill this gap by providing a quantitative analysis of the results of the studies that used PLWs to study social cognitive abilities in patients with schizophrenia. Furthermore, we also calculate the effects for two tasks which are based on point-light displays and were used as part of the SCAF project (Green et al., 2013). The first of these tasks – Basic Biological Motion task (BBM) – measures the ability to distinguish biological from non-biological motion (Kim et al., 2005; Kern et al., 2013). BBM has been successfully used to study social perception both in patients with schizophrenia (Kim et al., 2005, 2011, 2013; Kern et al., 2013; Jahshan et al., 2015) and in patients with OCD (Kim et al., 2008). The second task - Emotion from the Biological Motion (EBM; Heberlein et al., 2004) - measures emotion recognition abilities and has been applied across multiple psychiatric populations. The participants' task is to recognize the emotional state of the point-light agent who is displayed walking across the screen in either a happy, sad, angry, fearful or neutral manner. The task was initially used to study emotion processing in neurological populations (Atkinson et al., 2007; Heberlein et al., 2004). Since then, it has been applied in studies on emotion recognition in schizophrenia (Bigelow et al., 2006; Couture et al., 2010; Kern et al., 2013/Olbert et al., 2013; Vaskinn et al., 2015), major depressive disorder (Loi et al., 2013), Alzheimer's dementia (Henry et al., 2012), eating disorders (Lang et al., 2015) and autism (Couture et al., 2010).

We also aim to examine the association between biological motion processing and demographic, and clinical variables in patients. Finally, we aim to discuss the potential mechanisms that may impact the biological motion processing abilities in patients by systematically reviewing the existing literature on biological motion processing in schizophrenia.

2. Methods

2.1. Eligibility criteria for papers

The systematic review was planned and reported in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009; for PRISMA flowchart see Fig. 1).To be included in the analyses, studies had to fulfill the following criteria: (a) report original research data of the behavioral task associated directly with recognition (recognize biological motion presented concurrently with non-biological motion; e.g. Kim et al., 2005),

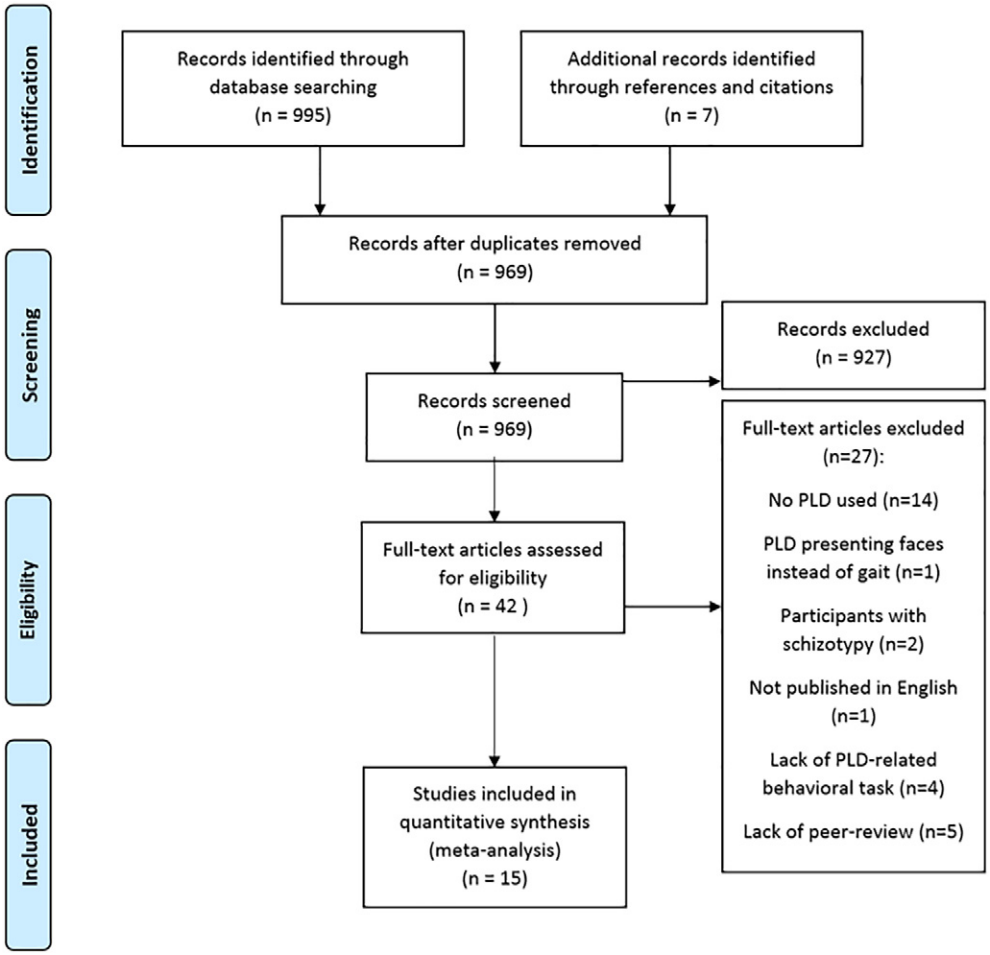

Fig. 1. PRISMA Flow Diagram.