Emotion Perception in Schizophrenia

Associations with neurocognition, symptoms and social functional outcome

Katharina Nymo

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IV

Abstract

Author: Katharina Nymo

Title: Emotion Perception in Schizophrenia. Relation to neurocognition, symptoms and social functional outcome.

Supervisor: Postdoctoral fellow Anja Vaskinn

Background: Due to its central role as a determinant of functioning in schizophrenia, social cognition has gained increasing attention from researchers the past two decades. There is however still a need to investigate, on a more detailed level, associations between separate domains of social cognition, symptoms and social functional outcome. In addition there is a need to develop new social cognitive measures that are applicable in clinical settings. These topics will be explored in this study by evaluating a measure of one social cognitive domain, emotion perception, adapted from the social neuroscience tradition. Associations between emotion perception and external factors; neurocognition, symptom level and social functional outcome, will be investigated. **Methods:** Participants in the study were 54 patients with a diagnosis of schizophrenia or schizoaffective disorder and 185 clinically healthy persons recruited from the Thematically Organized Psychosis research (TOP) study at the Norwegian Centre for Mental Disorders Research (NORMENT) K.G. Jebsen Centre for Psychosis Research. Emotion perception measure was the Emotion in Biological Motion (EmoBio) test. Symptom level was assessed with the Positive and Negative Syndrome Scale (PANSS) and neurocognition was measured with subtests from the Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) Consensus Cognitive battery (MCCB). Social functional capacity was indexed by the Assessment of Interpersonal Problem-Solving Skills (AIPSS) test and social functioning measure was the Social Functioning Scale (SFS). The student participated in data collection and -entry and conducted the statistical analyses. **Results/conclusions:** Patients performed significantly below healthy controls on emotion perception abilities measured with the EmoBio. Significant relationships were found with neurocognition, disorganization- and excitement symptoms. The relationship with social functional capacity was somewhat stronger than the relationship with social functioning, although neither of the associations reached statistical significance. Implications of the study are that it underlines the importance of detailed symptom assessment in schizophrenia. The use of EmoBio in evaluation of social functional outcome is however questionable.

Preface

Curiosity about the research process and an interest for schizophrenia as a disorder was my motivation to apply for a job as research assistant at the NORMENT K.G. Jebsen Centre for Psychosis Research in 2012. More than three years later, my interest in the field of schizophrenia research has not waned and any bewilderment about what should be the topic of my master thesis was therefore short-lived. I have really enjoyed the possibility to explore social cognition in schizophrenia.

My supervisor, Anja Vaskinn, thank you so much for inspiration, constructive feedback and great knowledge about schizophrenia and social cognitive research.

I am grateful to NORMENT for giving me the opportunity to use some of their data in my master thesis project. And to every participant in the TOP study at NORMENT I am very thankful for their time and effort.

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Katharina Nymo

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1 Introduction

1.1 Schizophrenia

Schizophrenia is a severe mental disorder and one of the top ten leading causes of disability in the world (Combs, Mueser, & Gutierrez, 2012). It typically develops between the ages 16 and 30, and is in many cases present throughout the patients' lifetime (Mueser & McGurk, 2004). Full recovery, however, is possible (Torgalsbøen, 2008).

Annual prevalence numbers of schizophrenia vary, but average around 15 per 100 000 with a lifetime risk of developing the disorder of 0, 7 % (Tandon, Keshavan, & Nasrallah, 2008). Incidence rates are relatively unaffected by culture and geography (Mueser & McGurk, 2004), although urbanicity and a history of migration seem to increase the risk for schizophrenia (Tandon et al., 2008). Male gender is also associated with a higher prevalence; according to the World Health Organization (WHO) worldwide numbers are about 12 million men compared to 9 million women (World Health Organization, 2014).

Schizophrenia is characterized by a reduced ability to separate oneself from others or one's surroundings, alongside other psychotic disorders (Johannessen, 2008). Diagnostic criteria for schizophrenia include hallucinations, delusions, disruptions of thought, disturbances of speech and behaviour, apathy and blunting of emotional responses (American Psychiatric Association, 2013; World Health Organization, 1993). Other common features of schizophrenia include mood symptoms such as depression, anger and anxiety, impaired social functioning, both interpersonally and professionally, and impaired self-care (Combs et al., 2012). The diagnostic criteria of schizophrenia provide a tool for clinical description, although as mentioned, other features characterize the disorder as well. Most common is the description of schizophrenia as consisting of three symptom groups; positive symptoms, negative symptoms, and cognitive impairments (Combs et al., 2012). A more thorough description of these three symptom groups will follow in section 1.1.1 and 1.1.2.

Schizophrenia has profound consequences for the individual, as well as for the person's surroundings (Millier et al., 2014). In addition, the disorder greatly affects society and health budgets (Mueser & McGurk, 2004). A combination of the relatively low age of onset and the

disorder's great impact on daily functioning contribute to high social costs. Numbers from the US indicate that it is the most costly mental disorder relative to the number of people affected.

With regard to aetiology, schizophrenia is a heterogeneous disorder (Tandon et al., 2008). The combination of genes and gene-environment interactions explain about 80 % of an individual's disposition for symptom development. The closer related a person is to a person with schizophrenia, the higher risk the relative has for developing schizophrenia. Numerous genes have been suggested to increase the risk for development of the disorder, alongside biological and psychosocial factors. Some examples of such biological and psychosocial factors are prenatal infections, perinatal complications and cannabis use. Poverty is another possible risk factor (Mueser & McGurk, 2004). Some general conclusions with regard to development of schizophrenia have however been made. Tandon et al. (2008) summarize that: "We believe that there is sufficient evidence to call schizophrenia a disease related to brain abnormalities that are the final 'common pathway' caused by an assortment of specific genetic and/or environmental factors" (p. 11).

1.1.1 Positive and negative symptoms

Negative symptoms refer to the absence or reduction in a function that is normally present, whereas positive symptoms refer to an altered mental function (Liddle, 1987), or something that is added to normal mental status (Kay, Fiszbein, & Opler, 1987). Examples of negative symptoms are social withdrawal, blunting of affective expression, anhedonia, apathy, and psychomotor impairment (Combs et al., 2012). Positive symptoms consist of hallucinations, delusions and odd or eccentric speech and behaviour (Green & Harvey, 2014).

The distinction between these two symptom groups in schizophrenia, is based on findings that implicate different prognoses and responsiveness to treatment (Kay et al., 1987). Antipsychotic medication shows greater effect on positive symptoms than negative symptoms, although about 20-30 % of patients do not receive symptom reduction from antipsychotic treatment (Millan, Fone, Steckler, & Horan, 2014). Negative symptoms, however, seem more strongly connected to functional outcome (Carbon & Correll, 2014). Negative symptoms also show greater stability across the course of illness than positive symptoms, as positive symptoms tend to be more fluctuating and even absent between psychotic episodes (Combs et al., 2012).

1.1.2 Cognition in schizophrenia

Cognitive impairments are common in schizophrenia (Sundet, 2008), and are also considered a core feature of the disorder (Green et al., 2004). As is the case for negative symptoms, cognitive impairments are less responsive to medication than positive symptoms, although second generation antipsychotics seem to have some effect. Cognitive impairments also correlate higher with functioning than positive symptoms (Green & Harvey, 2014).

As a contribution to the development of antipsychotic drugs that have better effect on cognitive deficits in schizophrenia, the National Institute of Mental Health (NIMH) initiated the Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) project (Green et al., 2004). One of the results from the MATRICS project was the establishment of consensus on seven cognitive domains implied in schizophrenia: Working memory, attention/vigilance, verbal learning and memory, visual learning and memory, reasoning and problem solving, speed of processing and social cognition. Deficits in all these cognitive domains have been found both in patients with a first-episode psychosis and in patients with a longer history of illness (Corigliano et al., 2014).

Another important goal for the MATRICS initiative was to establish a neuropsychological test battery that assesses all the above presented cognitive domains (Nuechterlein et al., 2008). After a process of nomination and evaluation of relevant neuropsychological tests, consensus was established on a test battery consisting of ten subtests called the MATRICS Consensus Cognitive Battery (MCCB) that is recommended for use in clinical settings for patients with schizophrenia (Nuechterlein et al., 2008).

1.1.3 Social cognition

Social cognition was, as mentioned above, one of the domains included in the MATRICS battery (Green et al., 2004). Deficits within all domains of social cognition is a feature of schizophrenia (Savla, Vella, Armstrong, Penn, & Twamley, 2013) which, like neurocognitive deficits, show stability across the course of illness (Green, Bearden, et al., 2012). Social cognition can be defined as "the ability to construct representations of the relation between oneself and others, and to use those representations flexibly to guide social behavior" (Adolphs, 2001, p. 231). A more thorough description of social cognition and the social cognitive domains within schizophrenia research is given in section 1.3.

1.2 Social functional outcome in schizophrenia

The term functional outcome in schizophrenia is complex, and it is therefore necessary to pay attention to how functional outcome is defined in different studies (Horan, Lee, & Green, 2013). It includes a range of different labels or terms and several outcome areas. It is likely, however, that functioning in one outcome domain is related to functioning in other outcome domains. For instance, a study focusing on occupational functioning found that better functioning at work was associated with better global, social and clinical functioning (Tandberg, Ueland, Andreassen, Sundet, & Melle, 2012).

When it comes to measurement of functional outcome in schizophrenia, assessment tools can be differentiated on basis of which domain of function it measures and which level of measurement it captures (see table 1). This distinction is further described in the following paragraphs.

As mentioned, a range of outcome domains are relevant to schizophrenia research, such as occupational functioning, community functioning or quality of social relationships. A rough distinction of functional domains is outcome areas that can be defined as social (Horan et al., 2013) and other areas such as employment status that for the purpose of this thesis will be defined as non-social, although employment is also seen included in the term social functioning (Couture, Penn, & Roberts, 2006).

Different ways of measuring each functional outcome domain could be referred to as different levels of measurement. Levels of measurement in social cognitive research are often labelled competence-based or attainment-based. The first group of measures aims to evaluate what a person is able to do under optimal conditions or the potential functional level for the person (Bowie, Reichenberg, Patterson, Heaton, & Harvey, 2006). Competence measures are observation based, and are often administered as role-plays or simulated social interactions (Harvey, Velligan, & Bellack, 2007). The second group of measures aims to capture what the person actually does on an everyday basis (Bowie et al., 2006). Often this category is divided into subjective measures or objective measures (Horan et al., 2013). Subjective measures gather information about the person's satisfaction with his or her life, while objective measures ask for facts about the person's life, such as marital status or income. Measures of functional capacity are more closely related to cognitive measures than social community function measures, because they are less affected by environmental factors (Schmidt, Mueller,

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& Roder, 2011). In contrast, Bowie et al. (2006) point out that performance- or attainment based measures could be influenced by several factors such as motivation and factors in the environment. This could mean that even though a person performs well on a measure of functional capacity, it is not necessarily implied that the person will show the same level of competence in daily life (Horan et al., 2013).

Given the complexity of terms and definitions regarding functional outcome in schizophrenia, the following terms have been chosen for the purpose of this thesis to underline that social aspects of functional outcome will be the main focus for this thesis: Social functional capacity will be used for competence-based measures and social functioning will be used for attainment-based measures. Social functional outcome will be the term including both types of outcome measures.

Table 1: Overview of social functional outcome in schizophrenia, the relationship between domains and levels of measurement

	Domain	
	Social	Non-social
Level	Competence-based	Competence-based
	Attainment-based	Attainment-based

1.3 Social cognition

Social cognition is a relatively new domain of research, which has gathered attention from schizophrenia researchers over the past two decades (Pinkham, 2014). As previously presented, social cognition became one of the domains represented in the MATRICS Consensus Cognitive Battery (Green et al., 2004), domains considered to be particularly important within research on cognition and schizophrenia. To underline processes that were especially important for schizophrenia research, the NIMH consensus-building meeting defined social cognition as "(…) the mental operations that underlie social interactions, including perceiving, interpreting, and generating responses to the intentions, dispositions, and behaviors of others." (Green et al., 2008, p. 1211). As Pinkham et al. (2014) point out, definitions of social cognition suggest that there is a strong connection between social

cognitive processes and social behaviour. Patients with schizophrenia show significant difficulties within all domains of social cognition (Savla et al., 2013), and these difficulties seem to be present early in the course of illness (Addington & Piskulic, 2013). This has implications for functional outcome, as presented in section 1.3.1.

Studies on the relationship between social cognition and neurocognition suggest that these two domains are best viewed as related, but separate constructs, and that deficits in social cognition cannot be explained by neurocognitive deficit (Pinkham, 2014). Already 18 years ago, Penn, Corrigan, Bentall, Racenstein, and Newman (1997) summarized findings in support of research on social cognition as an independent domain:

> (…) (a) Nonsocial-cognitive models alone may be limited to explain the social and clinical impairments in schizophrenia, (b) measures of social cognition contribute independent variance to social functioning beyond measures of non-social cognition, (c) patients with schizophrenia tend to perform differently on certain social-cognitive versus nonsocial-cognitive tasks, and (d) the content and process of hallucinations and delusions are consistent with distortions in social cognition. These findings suggest that assessment of social cognition can contribute important insights into the psychosocial and clinical sequelae of schizophrenia (p. 125).

Some of the arguments above will be discussed in following sections. In addition, newer research on social cognition confirms its role as an independent domain: Factor analytical studies such as Sergi, Rassovsky, et al. (2007) find that factor models fit better if social cognition and neurocognition are separated into individual factors. Correlational studies such as a meta-analysis by Ventura, Wood, and Hellemann (2013) also conclude that social cognition and neurocognition are best viewed as separate constructs. At the same time, support of social cognition and neurocognition as separate domains does not mean that the two domains are not related; researchers such as Green and Horan (2010) point out that the two domains are related, because to some extent they rely on common processes such as perception and working memory.

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Consensus has been established on four domains within social cognition, as a result of the Social Cognition Psychometric Evaluation (SCOPE) study (Pinkham et al., 2014). The SCOPE study was initiated to achieve consensus on domains for research on social cognition in schizrenia, to evaluate psychometric properties of social cognitive tests that already existed, and to establish a test battery suitable for use in clinical trials (Pinkham, 2014). The four core domains established for research on schizophrenia were: *Emotion processing, social perception, theory of mind/mental state attribution (ToM), and attributional style/bias* (Pinkham et al., 2014). In the following, a short presentation of the last three domains will be given. A more thorough presentation of emotion processing will be given in section 1.4, as it is the most relevant domain for this thesis.

Social perception refers to the processes that are involved in how people create a representation of themselves and others (Lundberg, 2013). It involves how we form impressions about other people and interpret social cues (Vaskinn, Sergi, & Green, 2009). This is strongly related to how people use contextual information in a social situation (Penn, Ritchie, Francis, Combs, & Martin, 2002). In social perception tasks, participants are required to use social cues to make inferences about situations or interpersonal domains such as intimacy, status, mood state and veracity (Sergi, Rassovsky, Nuechterlein, & Green, 2006).

Theory of Mind/mental state attribution (ToM) refers to a type of metacognitive ability that includes the ability to make inferences about other people's mental states, and to predict and understand behaviour such as intentions, beliefs and desires (Abu-Akel & Shamay-Tsoory, 2013). Mentalizing is another commonly used word for the ToM concept (Green & Horan, 2010).

Attributional style/bias includes inferences about the causes for people's behaviour (Green et al., 2008). Often, this is related to the reason why some positive or negative event happened. A common distinction in research on people's attributions is to divide between external situational, external personal and internal attributions. External situational factors are certain situations or events that lead to some kind of behaviour, external personal refers to when other people are cause of behaviour and internal attributions refer to causes within the person (Green & Horan, 2010).

1.3.1 Social cognition and functional outcome

As mentioned previously, deficits in several functional outcome areas are common in schizophrenia (Couture et al., 2006). Examples are social skills, occupational functioning and the ability to live independently. Functional impairments are present between psychotic episodes, and show limited improvement from treatment with antipsychotics. Clinical symptoms are also weak predictors of functional outcome (Horan et al., 2013). This has led to an increased focus on other factors that could be relevant predictors of functional outcome in schizophrenia, because understanding of the underlying factors connected to poor community functioning could aid treatment outcome (Couture & Penn, 2013).

The existence of neurocognitive deficits in schizophrenia is well established in research, and systematic investigations of both the magnitude and manifestations of these deficits have been made the last century (Green, 1996). In a literature review, Green, Kern, Braff, and Mintz (2000) discuss what could be the mechanisms for how neurocognition affects functional outcome in schizophrenia. They proposed that two factors act as mediators on the relationship between neurocognition and functional outcome in schizophrenia; learning potential and social cognition. Learning potential has later been disconfirmed in this role (Green, Llerena, & Kern, 2015; Vaskinn et al., 2008), but social cognition remains an important target for research.

In a review Couture et al. (2006) conclude that there are consistent findings when it comes to associations between several domains of social cognition and social functional outcome. More specifically, Fett et al. (2011) find in their meta-analysis that the associations between social cognition and social functional outcome yield effect sizes in the small to medium range, but with some variations depending on which social cognitive domain and which social functional outcome domain being investigated. They also find a stronger relationship between social cognition and functional outcome than between neurocognition and functional outcome (Fett et al., 2011). This is in line with an earlier finding by Vauth, Rüsch, Wirtz, and Corrigan (2004), who investigated the role of social cognition and nonsocial cognition in work-related social skills. They found that social cognition was a stronger predictor of vocational function that nonsocial cognition, but they also found that a large proportion of social cognition could be explained by nonsocial cognition. They conclude that the overlap in variance points toward confirmation of the hypothesis that social cognition serves as a mediator between nonsocial cognition and functional outcome. A review by Schmidt et al. (2011) compared studies of

social cognition as a mediator variable between neurocognition and functional outcome, and summarizes research on the field by stating that: "The results of our own statistical analysis are in line with these conclusions: Social cognition comprising emotion perception and social knowledge completely mediated a significant indirect relationship between neurocognition and functional outcome." (p. S49). Most of the studies included in their review that reported mediation effect, were studies of the emotion perception domain of social cognition. 15 years after social cognition and learning potential was proposed to be mediators of the relationship between neurocognition and functional outcome Green et al. (2015) recently stated that, based on studies such as the review by Schmidt et al. (2011), the "most closely examined mediator is social cognition, and the evidence is strong and consistent" (p. 3).

Green, Hellemann, Horan, Lee, and Wynn (2012) have developed an empirical model for the interrelations, or pathways, between neurocognition, social cognition and functional outcome in schizophrenia. The best fit of the data shows a path that runs from neurocognition (perception) through social cognition, then through beliefs and motivation and then finally to functional outcome. The authors point out that: "The term "pathway" in these models is largely developmental; ie, the interpretation is that early and relatively stable impairments in social and nonsocial cognition lead, over time, to motivational problems and ineffective community involvement." (Green, Hellemann, et al., 2012). For the purpose of this thesis, it is relevant to note the relative position on the path of neurocognition, social cognition, social functional capacity and social functioning (see figure 1).

Figure 1: Building on Green, Hellemann, et al. (2012): A simplified path model to functioning.
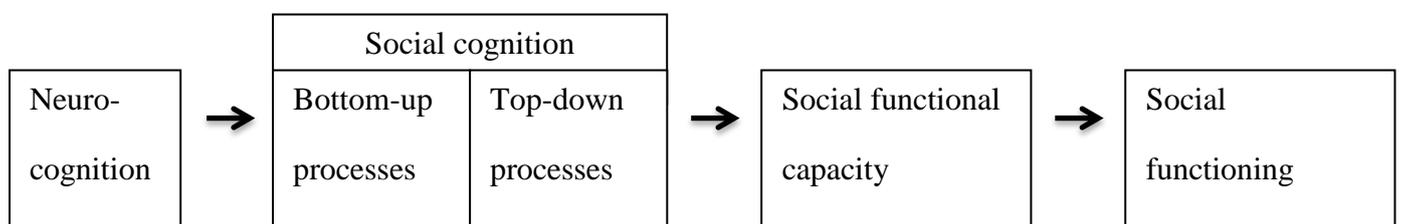
1.3.2 Social cognition and clinical symptoms

Some symptom groups have been more strongly associated with social cognitive functioning than others. One of the symptom groups is negative symptoms, and although negative symptoms and social cognition are related concepts (Sergi, Rassovsky, et al., 2007), a conclusion from the consensus conference (Green et al., 2008) was that social cognition and negative symptoms are best viewed as separate domains. The relationship between the two domains is however not clear (Green et al., 2008). Findings by Rassovsky, Horan, Lee, Sergi, and Green (2011) indicate that negative symptoms could be mediators on functional outcome, alongside social cognition, but that their pathways of impact are separate.

A suggestion regarding how social cognition and negative symptoms are interrelated is given by Sergi, Rassovsky, et al. (2007). They hypothesize that there might be a stronger association between social cognition and negative symptoms that involve reduced emotional experience or expression, than with other negative symptoms. Although not statistically significant, the results of a Norwegian study indicated that one type of negative symptoms, blunted or flat affect, was moderately associated with the social cognitive domain emotion perception (Vaskinn, Johnsen, Jorgensen, Kroken, & Loberg, 2013). The found association between affective blunting and emotion perception supports the hypothesis by Sergi, Green, et al. (2007) presented above.

In addition to negative symptoms, recent studies have suggested that disorganization symptoms might also be especially connected to social cognition in schizophrenia (Barkhof, de Sonneville, Meijer, & de Haan, 2015; Comparelli et al., 2014). A study by Barkhof et al. (2015) found significant associations between disorganization symptoms and a measure of facial emotion perception. Comparelli et al. (2014) found that impairments in facial emotion recognition were related to disorganization symptoms, and that this association was present independent of cognitive impairments. Some researchers have even proposed that the association between social cognition and disorganization symptoms is stronger than the association between social cognition and negative symptoms (Fett & Maat, 2013). However, meta-analytic findings indicate that both negative symptoms and disorganization symptoms are consistently associated with social cognition (Ventura, Wood, Jimenez, & Hellemann, 2013).

1.4 Emotion processing in schizophrenia

Emotion processing is one of the four domains in social cognition research that were considered particularly important for schizophrenia (Pinkham et al., 2014), and has therefore been a main target for research (Kohler, Hanson, & March, 2013). One definition states that "emotion processing refers broadly to perceiving and using emotions adaptively" (Green & Horan, 2010, p. 244). Often in research, the general concept of emotion processing is divided into subdomains or subprocesses. One way of conceptualizing the different subprocesses of emotion processing, is to differentiate between processes that are more complex and processes that are simpler (Pinkham, 2014). The more complex, or higher, level refers to emotion regulation and to manage emotion. The simple, or lower, level refers to recognition of emotions and emotion perception. Another way to differentiate emotion processing is into three dimensions; emotion perception, emotional experience and emotional expression (Kohler et al., 2013). These three processes are strongly involved in how people perceive and use social information (Lundberg, 2013), and difficulties in all dimensions have been found in schizophrenia (Kohler et al., 2013). In the following, findings on emotional experience and – expression will be presented briefly, before a more thorough presentation of emotion perception, or recognition, which is the main focus of this thesis.

Diminished emotion expression, often called blunted or flat affect, is now viewed as a characteristic of schizophrenia, and belongs among the negative symptoms (Kohler et al., 2013). A major challenge within research on flat affect is the lack of consistent instruments for measurement of affective flattening in facial expression. Flat affect seems to be present even early in the course of illness (Gur et al., 2006).

In relation to emotional experience, the concept of anhedonia, or reduced ability to experience pleasure, has been strongly connected to schizophrenia (Gard, Kring, Gard, Horan, & Green, 2007). It is important, however, to make a distinction between anticipatory and consummatory pleasure in relation to anhedonia in schizophrenia. Anticipatory pleasure refers to positive emotions because of some future event, and consummatory pleasure refers to positive emotion in the moment of doing an engaging activity. Patients with schizophrenia are able to experience as much consummatory pleasure as healthy controls, but they are impaired when it comes to anticipatory pleasure (Gard et al., 2007). Further, patients with schizophrenia report relatively strong emotional experiences although they show diminished

emotional expression, which indicates that emotional experience and -expression are not necessarily strongly correlated (Kohler et al., 2013). On the other hand, in-depth interviews with a group of participants with first-episode psychosis indicated that schizophrenia spectrum disorders are connected to an altered emotional experience (Vodusek, Parnas, Tomori, & Skodlar, 2014).

Emotion perception refers to the ability to accurately make inferences about what another person is feeling, to make judgments about emotional information (Couture et al., 2006). Face- or voice channel for communication is represented in the majority of research on emotion perception in schizophrenia, while other communication channels such as gestures or body posture are less represented (Kohler et al., 2013). Studies assessing both visual- and auditory emotion perception modalities make somewhat differing conclusions. Edwards, Pattison, Jackson, and Wales (2001) state that there are deficits related to emotion perception in both facial affect perception and affective prosody in schizophrenia, and it seems that abilities in the two modalities are positively correlated. They find impairments in emotion recognition for participants with a schizophrenia spectrum diagnosis, in both face- and voice communication channels (Edwards et al., 2001). Another study (Simpson, Pinkham, Kelsven, & Sasson, 2013) compared auditory and visual channels for emotion perception, and found that participants in the patient group performed significantly worse than participants in the control group on tasks in both modalities, but that performance in the visual task was better than in the auditory task. A Norwegian study found that patients with schizophrenia performed significantly worse than healthy controls only on an auditory emotion perception task and not on a visual emotion perception task (Vaskinn et al., 2007). Kucharska-Pietura, David, Masiak, and Phillips (2005) concluded in support of studies that suggest a perception deficit across modalities in schizophrenia, which has later been confirmed by Tseng et al. (2013).

One reason why facial expressions are well represented in research, is the concept of universal emotions and that certain facial emotional expressions are recognized across cultures (Kohler et al., 2013). Ekman et al. (1987) report findings in support of the existence of universal emotions. They find high consistency in a test where people from a range of cultures are assigned to label which emotion is conveyed by a facial expression. Ekman (1993) summarize their findings by stating that "(…) no one to date has obtained strong evidence of cross-cultural disagreement about the interpretation of fear, anger, disgust, sadness, or enjoyment

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expressions." (p. 384). However, this viewpoint has been challenged: A meta-analysis regarding the cultural perspective on emotion perception suggests that if the person expressing an emotion and the person who interprets the expression belong to the same ethnic group, interpretations of emotions are more often correct than if they belong to different ethnic groups (Elfenbein & Ambady, 2002).

A meta-analysis by Kohler, Walker, Martin, Healey, and Moberg (2010, p. 1009) concludes that: "Emotion perception impairment in schizophrenia represents a robust finding in schizophrenia that appears to be moderated by certain clinical and demographic factors." Examples of such demographic factors are age, hospitalization status and symptom level. They also suggest that emotion perception impairments have limited relationship with neurocognition. This result is in accordance with the finding by Edwards et al. (2001), who find a possible, but weak, mediating effect of IQ level on emotion recognition ability. In addition, it seems that the emotion recognition deficit seen in schizophrenia cannot be explained by a generalized recognition deficit, but that it is related to emotion recognition specifically (Bediou et al., 2007).

It is unclear to what degree emotion perception performance changes over time (Barkl, Lah, Harris, & Williams, 2014). The meta-analysis by Kohler et al. (2010) found, as mentioned, an effect by certain clinical factors, but they found no effect of duration of illness. According to a finding by Kucharska-Pietura et al. (2005), people with chronic schizophrenia perform worse on a facial emotion recognition task than people with only one or two psychotic episodes. However, average performance on emotion recognition was significantly better in the healthy control group. The finding that an emotion perception impairment is present early in the course of schizophrenia is in accordance with a recent meta-analysis conducted by Barkl, Lah, Harris, et al. (2014). They conclude that emotion perception deficits are found to be present early in the course of illness, and are therefore most likely a trait connected to vulnerability rather than a consequence of chronicity (Barkl, Lah, Harris, et al., 2014). Edwards et al. (2001) make a similar suggestion.

Barkl, Lah, Harris, et al. (2014) further suggest in their meta-analysis that some emotions are more difficult to identify than others. They find a more prominent impairment related to disgust, fear and surprise than to other emotions. Another recent study of young participants with first-episode psychosis found specific impairments in recognition of fear, disgust and anger (Barkl, Lah, Starling, et al., 2014). Other studies have found particular difficulty with

fear and sadness (Edwards et al., 2001), fear alone (Tseng et al., 2013), or surprise, fear and disgust (Leung, Lee, & Lee, 2011). Despite some variation, it seems that there is some consistency in that recognition of negative emotions is more difficult than other emotions for patients with schizophrenia (Barkl, Lah, Harris, et al., 2014).

1.4.1 Emotion perception and relation to functional outcome

The above mentioned meta-analysis by Couture et al. (2006) on the relationship between social cognition and functional outcome also specify that most of the studies they have reviewed show medium to large effect size for the relationship between emotion perception and some functional outcome areas in schizophrenia. As a recommendation for further research, they present that the relationship between specific social cognitive domains and specific functional outcome areas should be further investigated. Arguments encouraging to investigate if social cognitive domains are differentially related to functional outcome measures are also presented by Fett et al. (2011).

An attempt to clarify effect magnitude of emotion perception deficits on functional outcome was done by Irani, Seligman, Kamath, Kohler, and Gur (2012). They conducted a meta-analysis of studies on emotion perception and relation to functional outcome. They found a significant impact of emotion perception on functional outcome, with medium effect sizes. On a more detailed level, they found even stronger associations between emotion perception and functional outcome areas involving social problem solving and social skills.

More detailed knowledge on the associations between emotion perception and functional outcome could have implications for treatment. An example is a study by Mueller, Schmidt, and Roder (2015) which showed that training of neurocognitive abilities and social cognitive abilities such as emotion perception skills also was generalizable to improved social functional outcome.

1.4.2 Emotion in Biological Motion

Ochsner (2008) presents a theoretical framework, grounded in social neuroscience, for the organization of mental processes related to social cognition. Two of the processes, top-down and bottom-up processes, are argued to be the most relevant for clinical research in its current form. Both bottom-up and top-down processes refer to how social and emotional information

is recognized and evaluated. Shortly, in bottom-up processes inferences are made on the basis of experience. Founded on the concept of shared experiences it is implied that a specific experience will lead to a specific interpretation across people. On the other hand, in top-down processes, we can make inferences about information that might not mean what it appears to mean, or that is ambiguous. To make such information meaningful, we must apply a higher-level strategy than the bottom-up method; include contextual information in a situation or make use of symbolic representations. Applied on schizophrenia research, it is possible to distinguish between the different domains of social cognition by dividing them into bottom-up or top-down processes (see also figure 1). Emotion perception would be an example of a bottom-up process, whereas ToM would be an example of a top-down process (Ochsner, 2008).

Belonging to the group of bottom-up stimuli, an alternative measure of emotion perception in schizophrenia is not based on facial expressions, but on another visual stimulus, called point-light displays (Johansson, 1973), or point-light walkers in some studies (Heberlein, Adolphs, Tranel, & Damasio, 2004). In point-light displays a source of light is connected to a person's major joints while the person moves in a dark room. When watching such point-light displays we will only see the outline of a person. Studies have shown that humans can make a range of inferences from such limited sources of information, examples are bodily movement (Johansson, 1973), gender (Troje, 2002) and also emotional state (Dittrich, Troscianko, Lea, & Morgan, 1996). An important advantage of this type of stimuli is its connection to neural correlates. An example is a study by Heberlein et al. (2004) that used one specific test based on point-light walkers called Emotion in Biological Motion (EmoBio). In the study they compared participants with brain damage with healthy controls on tasks concerning judgments about both emotional states and personality traits. They found that impaired performance on an emotion judgment task and a personality judgment task was related to separate neural systems. They also found that impaired performance was connected to specific brain regions for the respective tasks.

Recognition of emotions from non-facial cues such as point-light walkers has received little attention in schizophrenia research, where facial emotion perception has been dominating. Couture et al. (2010) applied the EmoBio test described by Heberlein et al. (2004), and found that patients with schizophrenia showed emotion perception impairments even after controlling for IQ level.

Kern et al. (2013) point toward the need to develop new measures within social cognition research that are suitable for adults with schizophrenia. Using a test adapted from social neuroscience, with close relationship to neural substrates, were important factors in the Social Cognition and Functioning in Schizophrenia (SCAF) project (Green, Lee, & Ochsner, 2013; Kern et al., 2013; Olbert et al., 2013), where EmoBio was one of the tests included. Their evaluation of psychometric properties of social cognitive measures for the purpose of schizophrenia research showed that EmoBio discriminates between patients and healthy controls, that practice effects are small and that it is well tolerated by the person being tested (Kern et al., 2013).

1.5 Aims of the study

Building on the previous sections the aim of this study is to investigate, in a Norwegian sample, the properties of a relatively new measure of emotion perception in schizophrenia adapted from social neuroscience (Heberlein et al., 2004). In line with research from the SCAF project (Green et al., 2013; Kern et al., 2013; Olbert et al., 2013), this study aims to evaluate EmoBio as a social cognitive measure with regard to its ability to distinguish between schizophrenia patients and healthy controls, and to explore its associations with external measures. Building on the SCAF project's method of exploring psychometric properties of social cognitive tests, two different measures regarding social functional outcome, one measuring social functional capacity and one measuring social functioning, will be used. Studying cognitive function in schizophrenia is strongly connected to the development of possible interventions to improve function, and it is therefore important to investigate social cognitive measures' associations with social functional outcome (Olbert et al., 2013). In addition, correlations between emotion perception and symptom level will be investigated.

Symptoms will be measured with a five-factor model (Wallwork, Fortgang, Hashimoto, Weinberger, & Dickinson, 2012) of the Positive and Negative Syndrome Scale (PANSS) for schizophrenia (Kay et al., 1987). As previously mentioned the meta-analysis by Ventura, Wood, and Hellemann (2013) confirmed that disorganization symptoms were moderately related to social cognition in schizophrenia. Because of the findings when using an equivalent

factor model of PANSS as in this study, a stronger association with disorganization symptoms than with other symptom groups is expected.

Following conclusions from reviews on social cognition and functional outcome, this study aims to explore on a more detailed level the relationship between these two domains that are central features of schizophrenia as a disorder, and possible targets for intervention (Couture et al., 2006). A meta-analysis found a very small effect of antipsychotic medication on facial affect recognition, probably without clinical significance (Gabay, Kempton, & Mehta, 2014). This underscores the importance of understanding social cognitive processes on a more detailed level, to gain knowledge that might have treatment implications for schizophrenia. In another study, patients who received social cognitive intervention showed significant improvement on facial affect recognition, which could have consequences for their social functional outcome (Horan et al., 2009). A later meta-analysis of social cognition training by Kurtz and Richardson (2012) confirmed this finding, social cognitive training has a medium to large effect size on facial affect recognition, a larger effect than what was found for other social cognitive domains.

A pilot study of a social cognitive online training program indicated that patients improved not only on social cognitive measures but also on social functioning (Nahum et al., 2014). The authors, however, underline the importance of replications of this study.

Results from the SCAF project (Olbert et al., 2013) indicate that with regard to social cognitive measures with their roots in social neuroscience, these measures have stronger connections to functional capacity than to social functioning.

To summarize the aims of this study, hypotheses regarding findings are presented below.

1.5.1 Hypotheses

1: There will be group differences in emotion perception performance as measured with EmoBio, with healthy control participants performing better than participants diagnosed with schizophrenia.

2: In the patient group, emotion perception performance measured with EmoBio will be associated with social functional outcome, and the association is likely to be stronger with social functional capacity than with social functioning.

3: In the patient group, there will be an association between emotion perception performance measured with EmoBio and disorganization symptoms.

2 Methods

2.1 Participants

Participants in the study were 54 persons diagnosed with DSM-IV schizophrenia (N = 38) or schizoaffective disorder (N = 16) (American Psychiatric Association, 1994) and 185 clinically healthy persons (table 2). The inclusion of patients with both schizophrenia and schizoaffective disorder is not likely to affect the results substantially, as they share characteristics with regard to deficits both in neurocognition (Goldstein, Shemansky, & Allen, 2005) and emotion recognition abilities (Edwards et al., 2001; Kohler et al., 2010).

Both patients and controls were participants at the TOP study at the Norwegian Centre for Mental Disorders Research (NORMENT) K.G. Jebsen Centre for Psychosis Research. All participants signed informed consent prior to participation. The TOP study is approved by the Norwegian Regional Committee for Medical and Health Research Ethics (REK) and by the Norwegian Data Protection Authority.

Inclusion criteria in the study, independent of inclusion as a patient or control person, were as follows: Compulsory education in Norway or Norwegian as mother tongue, no current or past neurological disorder such as epilepsy, no past traumatic brain injury that caused hospitalization, and no severe somatic illness. Participants with an estimated IQ of 69 or below as measured with the Vocabulary and Matrix Reasoning subtests of the Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 2007), were excluded from the study.

For the control group, additional exclusion criteria were past or present severe mental illness among themselves or among their first-degree relatives, and substance abuse or addiction. Healthy controls were recruited by invitation letter sent to a random sample of habitants in counties Oslo and Akershus in Eastern Norway. The random sample was extracted by the Norwegian National Registry. All control participants completed the standard NORMENT neuropsychological test battery, a comprehensive neuropsychological test battery with social cognitive tests. In addition they underwent fMRI scanning and blood- and urine tests, although these data are not used in the current study.

Patients were recruited from in-and outpatient units or hospitals in the Oslo area. In addition to tests equivalent to the control group, they underwent a somatic examination and clinical interviews conducted by trained psychologists or medical doctors. Diagnostic evaluations were based on the Structured Clinical Interview for DSM-IV Axis I disorders (SCID-I) (First, Spitzer, Gibbon, & Williams, 1997). All interviewers completed a SCID training course based on the SCID assessment-training course at UCLA (Ventura, Liberman, Green, Shaner, & Mintz, 1998).

Table 2: Demographical data

	Patients	Controls
N =	54	185
Age (SD)	M: 28.7 (8.3)	M: 31.3 (7.9)
Sex	33 men	112 men
	21 women	73 women
IQ (SD)	M: 99.6 (13.1)	M: 113.6 (11.1)
Illness duration (SD)	M: 5.8 (6.0)[b]	
Illness age of onset (SD)	M: 22.2 (6.4)[b]	
GAF-F	M: 43.4 (9.7)[a]	
GAF-S	M: 40.6 (10.9)[a]	
Living condition	13 inpatients	
	41 outpatients	
Education	M: 11.7 (2.6)	M: 14.4 (2.1)[c]

Note. M = mean. SD = standard deviation. [a] = 1 missing. [b] = 4 missing. [c] = 7 missing.

2.2 Social cognitive measure

The social cognitive measure applied in this study was the Emotion in Biological Motion (EmoBio)-test presented in section 1.4.2, adapted from Heberlein et al. (2004). Participants were shown 22 short films on a computer screen, each with a point-light walker presenting an emotion (see figure 2). For every film, participants were asked to choose one of the following emotions that best described what the point-light walker they had seen in the film felt: Happiness, anger, sadness, fear or neutral emotion. Participants gave their replies by ticking

the relevant emotion on a paper. The scoring procedure was as described by Vaskinn et al. (submitted), adapted from Couture et al. (2010). A score for each of the 22 films is based on the proportion in the healthy control group that chooses a specific emotion, which gives room for a certain amount of variation in the results to be considered normal. If all of the healthy controls, 100 %, say that "happiness" is the correct emotion for one of the films, a choice of "happiness" on that film will provide 1.0 points and all other answers will provide 0 points. If the healthy control group considers the emotion expression more ambiguous, and no emotion is chosen by 100 % of them, scores are calculated based on the percentage for the emotion that most healthy controls consider correct. An example is that 60 % of the healthy control group say that the correct emotion is "sadness", 25 % say "neutral" and 15 % say "fear", then a choice of "sadness" will provide 1 point (60/60), "neutral" will provide .42 points (25/60) and "sadness" will provide .25 (15/60) points. An average score based on the 22 films was used in the analyses.

Figure 2: Example of a point-light walker (Kern et al., 2013).
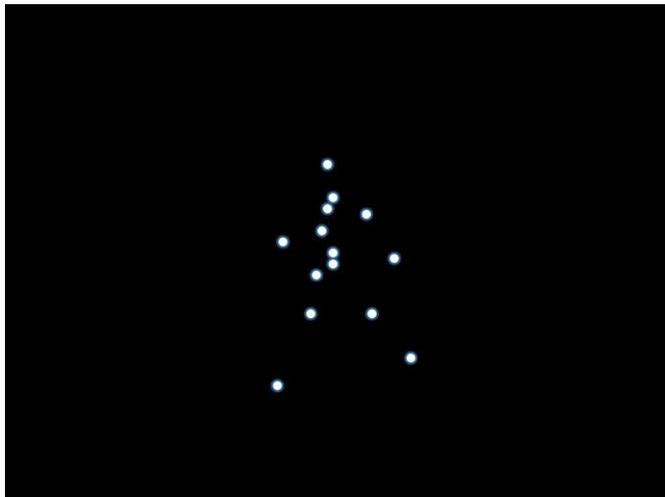
2.3 Clinical measures

2.3.1 Symptom measure

Symptom measures are based on Wallwork et al. (2012) and their five-factor model of PANSS (Kay et al., 1987) (see table 3). Several versions of five factor-models of PANSS

have been suggested since launching of the original version, and the suggestion by Wallwork et al. (2012) aims to establish a consensus five factor-model. The original version consisted of three subscales that included 30 items (Kay et al., 1987). For each item, a score of one to seven is assigned. One indicates absence of the symptom, and seven indicates strong presence of the symptom. In the five-factor model presented by Wallwork et al. (2012), scores are still one to seven for individual items, but the five factors only consist of 20 items instead of 30. The five factors are as follows: Negative, positive, disorganized/concrete, excited and depressed (see table 3). This factor structure has been confirmed to be the most optimal in a study of patients with first-episode psychosis in Norway (Langeveld et al., 2013). It has also been considered the most suitable model for PANSS in a Spanish sample (Rodriguez-Jimenez et al., 2013), and in Brazil (Higuchi et al., 2014). According to Higuchi et al. (2014), the Wallwork et al. (2012) five-factor model is the most replicated PANSS factor model over the last decade.

Given that the model by Wallwork et al. (2012) is relatively new, items belonging to each factor are presented here:

Positive factor: P1 (delusions), P3 (hallucinations), P5 (grandiosity) and G9 (unusual thought content.

Negative factor: N1 (blunted affect), N2 (emotional withdrawal), N3 (poor rapport), N4 (passive/apathetic social withdrawal), N6 (lack of spontaneity) and G7 (motor retardation).

Disorganized/concrete factor: P2 (conceptual disorganization), N5 (difficulty in abstraction), G11 (poor attention).

Excited factor: P4 (excitement), P7 (hostility), G8 (uncooperativeness) and G14 (poor impulse control).

Depressed factor: G2 (anxiety), G3 (guilt feelings) and G6 (depression).

Table 3: Overview of symptom level in patient group measured with PANSS five factors (Wallwork et al., 2012)

PANSS scale	Mean	SD	Range	Minimum [a]	Maximum [b]
Positive	10.54	3.92	16	4	28
Negative	11.89	5.75	28	6	42
Disorganized	5.98	2.87	16	3	21
Excited	5.59	2.67	15	4	28
Depressed	7.98	3.14	11	3	21

[a] Minimum possible symptom score for each scale. [b] Maximum possible symptom score for each scale

2.3.2 Measures of social functional outcome

Social functioning was assessed with the Norwegian version of the Social Functioning Scale (SFS), developed by Birchwood, Smith, Cochrane, Wetton, and Copestake (1990) (see table 4). It is a self-report form with scales that measure seven functional outcome areas: Social engagement/withdrawal, interpersonal behaviour, pro-social activities, recreation, independence – competence, independence – performance and employment/occupation. The SFS is standardized within a schizophrenia population, aiming to capture both strengths and weaknesses of the patient. A validation study of the Norwegian SFS showed satisfactory psychometric properties (Hellvin et al., 2010)

Social functional capacity was indexed by the Assessment of Interpersonal Problem-Solving Skills (AIPSS) test developed by Donahoe et al. (1990) (table 4). It is based on an information-processing model of social skills, and consists of three scales that each represents an information processing stage. These stages are the receiving stage, where a problem is identified or discovered, the processing stage, where possible solutions are evaluated and the sending stage, where a solution of the problem is presented and a response is given in a role-play. Even though functional capacity measures, as seen above, tend to correlate with neurocognitive functioning, findings regarding patients with schizophrenia and healthy controls, that do not differ on neurocognitive measures, indicate that the patient group still has significant problems when solving problems in the AIPSS test (Vaskinn, Sundet, Hultman, Friis, & Andreassen, 2009). In the AIPSS test, the participant is encouraged to imagine that he or she experiences a situation shown on a video-clip, and is also asked to identify with one of the characters in the video. In the original AIPSS version by Donahoe et al. (1990), 13 scenes

are shown to the participant through video-clips and in 10 of the 13 scenes a problem occurs. A short version of AIPSS was used in this study, consisting of five scenes, where a problem occurs in four of them. An example of such a problem in social interaction is one of the scenes where a couple are sitting in a café and a waitress is taking their orders. The waitress is summarizing their order wrongly, and the question is if there is a problem (receiving stage), what could be done about the problem (processing stage) and then finally the participant is asked to demonstrate a solution to the problem in a role-play (sending stage).

Table 4: Overview of social functional outcome measures applied in this study, building on table 1.

| | Domain | |
	Social	Non-social
Level	Competence-based AIPSS Attainment-based SFS	Competence-based Attainment-based

2.3.3 Measure of neurocognition

Part of the standard neuropsychological test battery at NORMENT is subtests of a Norwegian version of the MATRICS Consensus Cognitive Battery (MCCB) (Nuechterlein et al., 2008). All subtests were administered except from the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) from the social cognitive domain. The remaining nine subtests assess six cognitive domains: Speed of processing (Category Fluency, Symbol Coding, Trail Making Test – Part A), attention/vigilance (Continuous Performance Test – Identical Pairs version), working memory (Letter-Number Span, Spatial Span), verbal learning (Hopkins Verbal Learning Test), visual learning (Brief Visuospatial Memory Test – Revised) and reasoning/problem solving (Mazes). A study investigating properties of the Norwegian translation of the MCCB showed that it was sensitive to the neurocognitive impairments of patients with schizophrenia spectrum disorders, in all domains of cognitive function (Lystad et al., 2014). Another Norwegian study, of adolescents with early onset schizophrenia, found the MCCB to discriminate well between patients and controls, even in this relatively young

population (Holmén, Juuhl-Langseth, Thormodsen, Melle, & Rund, 2010). A composite score consisting of average T-score for the nine MCCB tests was computed for the purpose of use in this study.

2.4 Statistical analyses

All statistical analyses were conducted using the IBM SPSS Statistics Data Editor for Windows, version 22. Preliminary analyses using the Kolmogorov-Smirnov test of normality showed that some of the variables were normally distributed. Non-significant results ($p > .05$) on the Kolmogorov-Smirnov test were obtained for EmoBio scores, AIPSS and SFS in the patient group, which indicates normality for these variables (Pallant, 2007). EmoBio results in the control group gained a significant Kolmogorov-Smirnov test of normality ($p < .05$), which could indicate that the results differ from a normal distribution. However, both Field (2013) and Pallant (2007) state that the Kolmogorov-Smirnov test has a tendency to underestimate probability for normality in larger samples. Field (2013) also argues that the normality test has a tendency to do the opposite in smaller samples, that it overestimates probability for normality. With this background, additional indicators of normality were investigated. Measures of skewness and kurtosis and inspections of graphical presentations of the distributions, Q-Q plots and histograms, indicated that EmoBio results for the control group were normally distributed. Therefore, parametric analyses were conducted for the initial analyses; *t-tests* were performed to assess differences in EmoBio performance between patients and controls, and Pearson's *r* was used to investigate correlations between EmoBio performance and functional outcome in the patient group. Further analyses were conducted using non-parametric statistics (Spearman's *rho*) because subscales of AIPSS and symptom scores using PANSS were not normally distributed across the clinical group. Significance level was set at 5 %, and two-tailed tests were applied for all analyses. The effect size for the group comparison (Cohen's *d*) was computed using the pooled standard deviation for the two groups.

3 Results

The results are presented according to hypothesis: Chapter 3.1 refers to hypothesis 1, chapter 3.2 refers to hypothesis 2 and chapter 3.3 refers to hypothesis 3.

3.1 Group comparison

Results of the independent samples *t*-test is presented in Table 5. A medium to large effect size (Cohen, 1992) was found for the effect of group membership, patient or control, on EmoBio total score. The difference between means was statistically significant.

Table 5: Results from group comparison.

	Patient		Control				
	M	SD	M	SD	*t*	*p* value	Effect size (Cohen's *d)*
EmoBio	0.68	0.09	0.73	0.07	-4.07	< .01	0.67

3.2 Associations with social functional outcome and neurocognition

The associations between EmoBio performance, AIPSS total score, SFS total and MCCB composite score are presented in Table 6. Mean scores with standard deviations are also presented. A medium to large correlation (Cohen, 1992) was found between EmoBio performance and MCCB composite score, and this correlation was statistically significant. The association with SFS was approximately non-existent. A small to medium correlation

was found between EmoBio performance and AIPSS total score, but the correlation did not reach statistical significance.

Table 6: Mean scores for the neurocognitive measure and social functional outcome measures. Bivariate correlations (Pearson's *r*) between emotion perception and social functional outcome measures and MCCB.

	MCCB composite	AIPSS total	SFS total
Mean (SD)	38.35[a] (7.62)	59.46[b] (18.50)	105.53[c] (10.17)
EmoBio	.40**	.18	-.03

** Correlation is significant at the .01 level (2-tailed). [a] Mean based on T-scores. [b] Mean is based on percentage correct answers. [c] Mean scaled scores, normative mean = 100, SD = 15.

Separating the SFS into two subcategories of occupational functioning and a composite score of the remaining SFS social subscales did not have an effect on the result. Therefore, only the association between EmoBio performance and SFS total score is presented above.

Further analyses were undertaken to investigate the associations between EmoBio performance and subscales of AIPSS. Results are presented in Table 7. Small to medium correlations (Cohen, 1992) were found between EmoBio performance and all three AIPSS subscales, with the strongest association with AIPSS sending skills. None of the correlations were statistically significant.

Table 7: Bivariate correlations (Spearman's *rho*). Associations between emotion perception and subscales of the social functional capacity measure.

	AIPSS rec. skills	AIPSS proc. skills	AIPSS send. skills
EmoBio	.17	.10	.20

3.3 Associations with symptoms

Correlations between EmoBio performance and the five factors of PANSS are presented in Table 8. Associations with PANSS disorganized- and excited scales were medium sized and statistically significant. Associations with PANSS positive- and negative scales were small,

and the association with PANSS depressed scale was approximately non-existent. Neither of the latter reached statistical significance.

Table 8: Bivariate correlations (Spearman's *rho*). Associations between emotion perception and PANSS five factors.

	PANSS positive	PANSS negative	PANSS disorganized	PANSS excited	PANSS depressed
EmoBio	-.13	-.14	-.31*	-.28*	-.03

* Correlation is significant at the .05 level.

4 Discussion

Following the initiative by the SCAF project (Kern et al., 2013; Olbert et al., 2013), the goal of this study was to investigate the properties of a relatively new measure of social cognition in a Norwegian sample of schizophrenia patients and healthy controls. A measure of emotion perception adapted from social neuroscience, EmoBio as presented by Heberlein et al. (2004) was examined with regard to its ability to distinguish between schizophrenia patients and healthy controls and its associations with social functional outcome and clinical symptoms. Hypotheses were largely based on findings from the SCAF project. Due to the use of a five-factor model of PANSS (Wallwork et al., 2012), which is not used in the SCAF study, additional findings on the relationship between social cognition and symptoms were used in the development of hypothesis three.

Although some of the correlations did not reach statistical significance, the overall pattern of the results is in line with the hypotheses. Mainly carried out according to structure of the hypotheses, a more thorough discussion of the results will be given in the following sections. First, results of the group comparison will be discussed, followed by a discussion of the associations between emotion perception performance and neurocognition. Then, focus will be on associations between emotion perception and symptoms. After that, a discussion of the associations between emotion perception and social functional outcome will be presented. Finally, some implications for treatment, limitations of the study and possible recommendations for further research are discussed.

4.1 EmoBio: Case-control comparison

This study replicated the findings by Kern et al. (2013) regarding EmoBio's ability to detect a deficit in emotion perception among patients with schizophrenia. An effect size of 0.67 (Cohen's *d*) was detected, which is practically equivalent to 0.69 in the Kern et al. (2013) study. Although the difference in mean points is quite small when comparing patients and controls' EmoBio performance, this similarity in results strengthens indications that EmoBio is able to consistently perceive aspects of a deficit in emotion perception abilities among

patients with schizophrenia. The use of a slightly different version of the EmoBio test in this study compared to Kern et al. (2013) does not seem to have affected the result. Kern et al. (2013) used an adaptation of the Heberlein et al. (2004) EmoBio test that included 30 point-light walker clips, which is slightly longer than the 22-clip version used in this study. The five emotions presented (fear, anger, happiness, sadness or neutral), were however the same as in the present study.

A characteristic of the current sample is worth mentioning in relation to the difference between patients and controls. Mean age of participants in this study is about ten years younger than participants in the Kern et al. (2013) study, where mean age for patients is 42.8 and mean age for healthy controls is 42.6. Age of illness onset in the patient group is however almost identical in the two studies, which indicates a sample of more chronic schizophrenia in the SCAF sample. The similarities in results on EmoBio, despite differences in sample characteristics, indicate that EmoBio captures a trait-like phenomenon in schizophrenia. A finding in support of a stable emotion perception deficit in schizophrenia is in line with the previously mentioned conclusions by Barkl, Lah, Harris, et al. (2014) and Edwards et al. (2001), who argue that an emotion perception deficit is best viewed as a trait marker of the disorder.

4.2 Associations with neurocognition

The correlation between performance on EmoBio and neurocognitive performance was statistically significant and at the moderate level (Cohen, 1992), which is in line with the finding by Olbert et al. (2013). They have also excluded the MSCEIT test from the analysis to make a MCCB composite score that consists only of non-social cognition measures.

The association between social cognition and neurocognition is expected, and part of the background for the association is summarized by Green and Horan (2010): "Neurocognitive and social cognitive tasks often share cognitive processes, such as working memory and perception, and therefore are clearly associated" (p. 244). At the same time, as presented earlier, social cognition and neurocognition are best viewed as separate domains (Green et al., 2013). Looking at the model for a path to functioning as presented by Green, Hellemann, et al. (2012) gives further understanding to the found association between EmoBio performance

and neurocognitive functioning (figure 1).. Social cognition is found next to neurocognition in the pathway, with direct effects from neurocognition. In addition, as EmoBio is a bottom-up type of stimulus (Ochsner, 2008), it is probably even more strongly connected to neurocognitive abilities than if a top-down process was measured instead. This theoretical foundation for the association between emotion perception and neurocognition was, at least to some degree, investigated by Mancuso, Horan, Kern, and Green (2011), who found large correlations between MCCB results and a set of social cognitive tests including an emotion perception test based on facial expressions. A correlation in the large range is somewhat larger than the moderate correlations found in the present study. Based on these findings the authors hypothesize that so-called "lower-level social cue detection" is more strongly correlated with neurocognition than with what they call "higher-level inferential and regulatory processing". This finding underlines that the distinction between bottom-up and top-down processes is relevant to the current findings, and lends support to the expectation of a stronger connection between neurocognition and bottom-up processes than between neurocognition and top-down processes. Such a distinction might also be part of the explanation of the possible discrepancy between the current findings and the findings by Kohler et al. (2010), as they suggest in their conclusion that impairments in emotion perception have limited relationship with neurocognition.

4.3 Associations with symptoms

This study found a statistically significant, medium sized correlation between EmoBio performance and the disorganized and excited scales of PANSS.

The association with disorganization symptoms is in line with the hypotheses, that were based on findings such as the previously mentioned meta-analysis by Ventura, Wood, and Hellemann (2013). Despite differences in how symptoms and social cognition are assessed in schizophrenia, there is consistency across studies with disorganization symptoms showing moderate correlations with emotion perception abilities. Because of the differential association between EmoBio performance and positive symptoms compared to disorganization symptoms, this study also supports the conclusion that positive symptoms and disorganization symptoms in schizophrenia are separate dimensions that are differentially

associated with social cognition (Ventura, Wood, & Hellemann, 2013). Studies that applied less detailed symptom scales such as the original PANSS positive scale (Kay et al., 1987), have found less consistent connections between social cognition and symptom level (Kohler et al., 2010), which does also support a differential association between positive symptoms, disorganization symptoms and social cognition.

Unlike the present study, the SCAF project study (Olbert et al., 2013) did not find a significant association between EmoBio performance and symptoms. A possible explanation for this difference in findings is the above presented discussion of differences in measurement. The Brief Psychiatric Rating Scale (BPRS) (Overall & Gorham, 1962) positive scale was applied for measurement of positive symptoms, and only one positive symptom scale was presented, which challenges a direct comparison of results in the SCAF study and the present study. The current results are in line with other studies that have applied a five-factor model of PANSS, such as the previously described Barkhof et al. (2015) and Fett and Maat (2013) which also found associations between emotion perception and disorganization symptoms. In a recent study from a NORMENT research group that used a largely overlapping patient sample with the present study, a small to moderate correlation of trend level significance between disorganization symptoms and another social cognitive domain, ToM, was found (Fretland et al., 2015).

Explanations have been proposed regarding the function of disorganization symptoms in relation to other domains such as neurocognition and social functional outcome. Minor and Lysaker (2014) suggest that disorganization symptoms act as a moderator on the relationship between neurocognition and social cognition. Another study suggested that disorganization symptoms might be a better predictor of functional outcome than other symptom groups (Ortiz et al., 2015). A theoretical model aiming to explain the foundation for disorganization symptoms proposes that people with schizophrenia have difficulties when it comes to integrating contextual information in a situation (Hardy-Bayle, Sarfati, & Passerieux, 2003). As the disorganization factor in this study include the three items conceptual disorganization, difficulty in abstraction and poor attention it is possible that higher scores on the disorganization factor is associated with lower scores on the EmoBio because of the symptoms leading to difficulty with integration of information. Contrasting findings do however exist, indicating that patients with schizophrenia do not show impairments when it

comes to integration of contextual information compared to healthy controls (Lee et al., 2013).

Another finding in this study was the statistically significant, medium-sized, negative association between EmoBio performance and the excited scale of PANSS, which stands in contrast to previous studies (Barkhof et al., 2015; Comparelli et al., 2014; Laroi, Fonteneau, Mourad, & Raballo, 2010). Again, the use of different PANSS factor models could be a possible explanation for the difference in findings, although the excitement scale usually includes the same items across PANSS models. An example is Comparelli et al. (2014). Further on, some studies have applied a general positive symptoms factor that also includes excitement symptoms (Fett & Maat, 2013). Applying a general positive factor could hide possible specific associations between emotion perception abilities and excitement symptoms in schizophrenia.

The excited scale applied in this study includes four items; excitement, hostility, uncooperativeness and poor impulse control (Wallwork et al., 2012). It would not be surprising that it becomes difficult to focus on quite ambiguous, attention-demanding tasks such as EmoBio, if experiencing these symptoms to a certain degree.

A factor that could have affected the associations between symptoms and social cognition is the general symptom level in the patient group. Studies mentioned in this section have applied other factor models of PANSS than the present study that includes a different number of items in each scale. The differences in PANSS models applied make direct comparisons of symptom level in the discussed studies difficult, and comparison with other studies that have applied the Wallwork et al. (2012) factor model is probably more meaningful. An example is a Norwegian study by Berg et al. (2014). They find mean symptom level on the disorganized and excited factors to be 5.3 and 5.7, respectively, which is approximately the same as in the present study's symptom levels of respectively 5.98 and 5.59 on the disorganized and excited scales. In a Chinese sample, however, mean symptom levels were 7.6 and 5.4 (Zhou et al., 2015), which might suggest that the disorganization symptom level is relatively low in the present sample. It might also be an indicator that EmoBio is very sensitive to disorganization symptom level.

4.4 Associations with social functional outcome

The associations between emotion perception assessed with EmoBio and social functional outcome were small, and failed to reach statistical significance. However, the correlation with social functional capacity was at the small to moderate level, which is stronger than the approximately non-existing association between emotion perception and social functioning. A stronger association between a social neuroscience measure and social functional capacity than social functioning is in line with the hypotheses of this study.

Conclusions from meta-analyses and reviews such as Irani et al. (2012) and Couture et al. (2006) give reason to expect that emotion perception and functional outcome are strongly connected, with correlation coefficients averaging at the moderate to large level. This is substantially stronger relations than in the current study. The association between emotion perception and functional outcome does also seem to be found in spite of the application of a range of different outcome measures and domains and, as found in the current study, they find the weakest associations between emotion perception and community functioning (Couture et al., 2006; Irani et al., 2012). These findings give reason to expect that, if an emotion perception measure captures the concept of emotion perception as a social cognitive domain, it should be more strongly associated with social functional outcome than EmoBio is found to be in the current study.

There is, however, a large degree of heterogeneity among findings on the relationship between emotion perception and social functional outcome (Irani et al., 2012). A possible explanation for this heterogeneity in findings is different measures of emotion perception, as seen in the present study. One important explanation for the relatively weak association found between EmoBio performance and social functional outcome measures is that EmoBio is, as discussed in a previous section, a bottom-up measure adapted from the social neuroscience tradition (Ochsner, 2008) and is therefore theoretically more strongly associated with neurocognition than other types of social cognitive measures. Building on the structure of the path model by Green, Hellemann, et al. (2012), a concept that is more strongly associated with neurocognition would be less associated with social functional outcome than a concept that is found closer to social functional outcome along the path to functioning. A relatively stronger association between social cognition and social functional capacity than between social cognition and social functioning would also be meaningful in the context of a path

model to functioning, because social functioning is theoretically further away from social cognition on the path than functional capacity.

The pattern of associations between EmoBio performance and different aspects of social functional outcome is also in line with the distinction between competence-based and attainment-based measures of social functional outcome (Harvey et al., 2007). As social functioning measures could be more easily affected by environmental factors than functional capacity measures (Schmidt et al., 2011), a closer link between EmoBio and AIPSS than between EmoBio and SFS is to be expected. Both AIPSS and EmoBio are standardized tests conducted in a setting free from the disturbances of everyday life, which might contribute to test performance. As opposed to AIPSS, other factors than the person's ability will impact on the results on SFS.

The measure of functional capacity is different in this study from in Olbert et al. (2013), which might contribute to the difference in significance levels for the correlations between EmoBio performance and the functional capacity measure. In this study it is a subscale of AIPSS, sending skills, that is most equal to the functional capacity measure used by the SCAF project. SCAF uses the Maryland Assessment of Social Competence (MASC) test (Bellack, Brown, & Thomas-Lohrman, 2006; Bellack, Sayers, Mueser, & Bennett, 1994), a test based on role-play where the participant's task is to solve interpersonal problems. As mentioned in section 2.3.2, the sending skills scale is based solely on the role-play in AIPSS (Donahoe et al., 1990). Another factor that is relevant in this context is that the current study has a substantially smaller patient group than the SCAF study, 54 patients compared to 173. A larger sample yields higher probability that smaller effects will be detected (Cohen, 1992). However: Although the correlation is not statistically significant, when looking at the association between EmoBio performance and the AIPSS sending skills scale in this study ($rho = .20$) the correlation coefficient is at the same size as in the SCAF study ($r = .23$). This indicates that independent of which measure used, EmoBio performance is to some extent related to social functional capacity in schizophrenia.

The association between EmoBio performance and the measure of social functioning in this study was approximately non-existent. In the SCAF study (Olbert et al., 2013), a small but not statistically significant correlation is found between EmoBio performance and their measure of social functional outcome, the Role Functioning Scale (RFS). The RFS (McPheeters, 1984) as applied in the SCAF project consists of four subscales that measure work functioning,

independent living, family network and social functioning. These social functioning domains are overlapping with the domains included in the SFS measure applied in this study, which does not give reason to believe that the use of a different measure than the SFS for social functioning would impact strongly on the results of this study.

4.5 Implications for treatment

The previously discussed association between social cognition and functional outcome has led to increased interest in development of interventions that could enhance social cognitive functioning in schizophrenia, and hence strengthen functioning in real-life (Green & Horan, 2010). Among other aims, to investigate how social neuroscience measures relate to social functional outcome was a primary goal for the SCAF project studies (Green et al., 2013; Kern et al., 2013; Olbert et al., 2013).

This study found that EmoBio was only weakly associated with social functional outcome, in line with Olbert et al. (2013). Building on a path model from neurocognition to functioning (Green, Hellemann, et al., 2012), the EmoBio is probably too far from actual functioning to be a good predictor of social functioning in its current form. Therefore, in line with recommendations from the SCAF project on the use of social neuroscience measures in clinical trials (Olbert et al., 2013), the results of this study indicate that EmoBio is not a strong indicator of improvements in functioning. Improvement of emotion perception abilities in schizophrenia is possible, with reason to expect improvements in the moderate to large range (Kurtz & Richardson, 2012). Therefore, it is likely that training of emotion perception abilities could yield improved EmoBio performance. The consequences of improved EmoBio performance for social functional outcome is however questionable.

This study showed that EmoBio is able to detect differences between schizophrenia patients and healthy controls, and that the emotion perception deficit is significantly associated with both neurocognition and two symptom groups; disorganization- and excitement symptoms. The significant associations with symptoms have possible implications for treatment. Across studies (Ventura, Wood, & Hellemann, 2013), the current study included, there is a degree of consistency in results regarding disorganization symptoms and social cognitive measures, which indicates that this symptom group is especially involved in, or might especially affect,

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social cognitive functioning. Because the present study applied correlational analyses inferences about causality are not implicated, but former studies have implied disorganization symptoms as a predictor of emotion perception (Barkhof et al., 2015). Improvements in disorganization symptoms, and possibly also excitement symptoms, could therefore be associated with improved social cognitive abilities.

4.6 Limitations of the study and recommendations for further research

There are some limitations to this study that need to be emphasized. First, as mentioned in the previous section, due to the use of correlation analyses this study is limited in drawing inferences about causality. Because of the rather small sample size in the patient group, correlational analyses were chosen (Field, 2013). The results showed that some of the measured domains were interrelated, but which factor is a predictor of the other must be inferred on the basis of already existing research.

Secondly, to control for certain factors might be relevant to studies of emotion perception, as e.g. gender has been shown to impact on the results of both facial emotion perception tests (Vaskinn et al., 2007) and judgments of emotion expression from point-light walker displays (Alaerts, Nackaerts, Meyns, Swinnen, & Wenderoth, 2011). Women performed better than men on both types of tasks. Because EmoBio performance was associated with neurocognition at the moderate to large level, and because mean IQ is estimated to be almost one standard deviation higher in the control group (M = 113.6) than in the patient group (M = 99.6), an investigation of the impact of IQ level on the results could have been relevant to this study.

A third limitation is related to the symptom measure applied in this study. Although the PANSS is widely used in clinical settings, newer tools for symptom measurement in schizophrenia have been developed. There are indications that negative symptoms are related to social cognition, but investigations of the interrelations between the two domains would probably benefit from the use of symptom measures that give a more detailed picture of negative symptoms (Kirkpatrick, Fenton, Carpenter, & Marder, 2006). Building on recommendations from the NIMH-MATRICS Consensus Statement on Negative Symptoms

(Kirkpatrick et al., 2006), the Clinical Assessment Interview for Negative Symptoms (CAINS) has been developed (Kring, Gur, Blanchard, Horan, & Reise, 2013). Applying measures such as CAINS could aid understanding of how negative symptoms are connected to social cognition.

As pointed out by Ventura, Wood, and Hellemann (2013), the "question remains as to how the domains of social cognition are related to the key domains of neurocognition". The relationship between social cognition and neurocognition has been discussed in this study, and the relationship between neurocognition and one social cognitive domain has been investigated. At the same time, as a composite score of the MCCB was applied, possible differential associations between social cognition and aspects of neurocognition have been hidden in the present study.

As consensus has been established regarding the role of social cognition as a mediator between neurocognition and social functional outcome (Schmidt et al., 2011), a possible goal for further research on social cognitive measures adapted from social neuroscience is to investigate if these measures also act as mediators the way social cognition is expected to do. If measures such as the EmoBio act as a mediator, it strengthens the belief that this type of measures captures the social cognitive domain it is intended to measure and not another aspect of the task such as neurocognitive abilities.

Although newer measures of symptoms in schizophrenia have been developed, the current study found an additional symptom group, excitement symptoms, to be related to social cognitive functioning. This finding indicates that the application of PANSS five factor models could also yield more detailed knowledge about the interrelations between symptoms and social cognition. The link between excitement symptoms and emotion perception abilities requires further research to investigate if the association is dependent on EmoBio as emotion perception measure or if it is generalizable to other aspects of emotion perception abilities such as facial emotion perception, and possibly also to other social cognitive domains.

5 Conclusions

The goal of this study was to investigate, in a Norwegian sample, the properties of a social cognitive test of emotion perception abilities called Emotion in Biological Motion (EmoBio). The test is adapted from the social neuroscience field of research, with advantages being that the processes measured by the test have known neural correlates. EmoBio was tested regarding its ability to distinguish between patients with schizophrenia or schizoaffective disorder and healthy control persons. Further on, associations between EmoBio performance and external measures were examined. The results showed that EmoBio was able to consistently differentiate between patients and controls. The deficit that the patients showed on emotion perception abilities was significantly associated with disorganization and excitement symptoms of schizophrenia, but not with other symptom groups. Looking at the associations between emotion perception abilities and social functional outcome, none of them reached statistical significance, although the association with social functional capacity was stronger than the association with social functioning. These results are meaningful in the light of a path model to functioning, with simpler bottom-up processes as measured with EmoBio taking a place closer to neurocognitive functioning than more complex, top-down, processes that are found closer to social functional outcome. Implications are that more comprehensive measurement of symptoms in schizophrenia is necessary, to possibly improve social cognitive functioning and thereby indirectly improve social functional outcome. EmoBio might, however, be limited in its ability to systematically detect improvements in social functional outcome among patients with schizophrenia.

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