Context Processing and Social Cognition in Schizophrenia

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Abstract: Recent empirical and theoretical work has conceptualized cognitive deficits in schizophrenia in terms of a deficit in the processing of contextual information [1, 2]. Context processing deficits have been shown to underlie impairments in multiple cognitive domains, and may thus represent a core disturbance in information processing in schizophrenia. Despite the increasing evidence for impaired context processing, there has been little research into the relevance of these deficits for an understanding of social cognition in schizophrenia. In the present paper, we argue that deficits in the processing of context may also be relevant for explanations of deficits in social cognition in schizophrenia. We review evidence to suggest that efficient context processing may be necessary for the acquisition and maintenance of social cognitive skills, such that deficits in context processing may be a common factor underlying deficits in both social and non-social cognition in schizophrenia. Future research should examine relationships between specific social cognitive skills (such as facial expression perception, mental state inference) in relation to context processing during non-social perceptual and cognitive tasks.

1. INTRODUCTION

Context-processing abnormalities have long been implicated as a core feature of schizophrenia [3]. In recent decades considerable evidence has emerged from a variety of experimental paradigms to support the notion that deficient context processing exists in schizophrenia (reviewed by Phillips and Silverstein, [1]). However, context has been defined in different ways by different investigators. For example, Cohen and Servan-Schreiber [2] identify context with task-relevant information supplied by preceding events that is manipulated in working memory (WM) according to task requirements. For others (e.g., [4, 5]), context is associated with activation of relevant stored material in long-term memory which leads to 'expectancies' or 'response biases' to facilitate efficient behaviour. While these models converge in proposing that context exerts a top-down influence upon perception and cognition, a more recent model by Phillips and Silverstein [1] proposes that stimulus driven information (i.e., concurrent context) may interact with top-down schemata stored in long-term and working memory. Although these formulations of context differ in important aspects, Phillips and Silverstein's [1] model succeeds in proposing a common framework for the understanding of context processing dysfunction in schizophrenia. In their view, context represents a class of "…interactions that affect the salience or dynamic grouping of neuronal signals without changing what they mean" (p. 3) and it is proposed that such interactions occur at different levels, and across domains of information processing.

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Despite the parsimony of theories emphasizing contextual processing deficits as the basis of various cognitive dysfunctions in schizophrenia, the relevance of context processing has so far not been considered with respect social cognition in schizophrenia. Deficits in social cognition are a pervasive feature of the disorder which affect the ability to engage in social relationships, attend to self care, maintain employment, and participate in recreational or community activities [6, 7], such that their amelioration is a major goal of psychosocial interventions.

In the present paper, we aim to show that deficits in social cognition in schizophrenia may be linked to aberrant context processing, drawing on evidence from developmental psychology and experimental psychopathology which indicates a role for context-processing in 1) the acquisition and maintenance of social-cognitive skills; and 2) the explanation of social cognition in schizophrenia. We will firstly provide a brief summary of the main findings on context-processing in schizophrenia, followed by a review of the research on facial emotion perception and Theory of Mind (ToM) impairments in schizophrenia, which suggests that deficient context-processing may at least partially account for such deficits. We then discuss the evidence from developmental psychology and neuroscience to suggest that contextual information may play a role in the development and maintenance of social cognitive skills, especially in relation to those that are impaired in schizophrenia (i.e., face processing, mental state inference, and social cue perception). Finally, we will propose recommendations for future research in this area

2. CONTEXT-PROCESSING IN SCHIZOPHRENIA

Context-processing deficits in schizophrenia have been observed on measures of sustained attention, selective

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attention, and lexical disambiguation [2, 8], latent inhibition [4, 9], and early visual organization [1], and a growing number of theorists have attempted to explain the diverse range of cognitive deficits in schizophrenia on the basis of a single underlying impairment in context-processing.

Different conceptions of context processing may nonetheless share a common role in information processing. It has recently been speculated that the brain may utilise common computational algorithms to implement context-dependent information processing across cognitive domains. On this view, context plays a modulatory role in information processing by influencing the choice between possible interpretations, by making relevant signals more salient, and by grouping those that go together [1]. Effective integration of contextual information may thus encompass both concurrent contextual information (such as that contained in perceptual stimulus properties) as well as top-down mediated contextual information (such as that derived from abstract information, or the use of learned heuristics according to task requirements).

2.1. Perceptual Organization – The Role of Concurrent Context

A paradigmatic example of the influence of concurrent context in cognition is perceptual organization. In perceptual organization, the visual context is represented by stimulus elements which determine which features are grouped together to define emergent object representations, while the stimulus elements remain basically the same. Many studies have provided evidence for perceptual organization deficits in schizophrenia [10-15]. Notably, the use of psychophysical tasks in these studies has revealed that visual organization deficits in schizophrenia can lead to superior performance when accuracy depends on isolating individual stimulus elements apart from their context [11, 15-17].

However, schizophrenia patients' deficit in perceptual organization may be linked to specific parameters of the task employed. For example, there is evidence to suggest that deficits in perceptual grouping in schizophrenia patients vary as a function of the degree to which organization must be actively imposed on the stimuli (and conversely, the degree to which the stimuli contain prepotent cues to grouping). Thus, processing of stimulus elements with fewer configural properties and where perceptual groups are determined by past experience, current context and other top-down factors is impaired in schizophrenia [10, 16, 18, 19]. Conversely, processing of stimuli with prepotent structure and other stimuli with strong configural properties (e.g., configural stimuli with and without continuous contours) is intact in schizophrenia [19-21].

2.2. 'Top-Down' Context Processing

2.2.1. Contextual Disambiguation: The Role of WM

A prominent conceptualisation of contextual information is that which is "actively held in mind in such a form that it can be used to mediate task appropriate behaviour" [8]. Studies by Cohen and colleagues [2, 8, 22] have typically employed tasks in which contextual information is used to modify the processing of information about other things, with efficient use of context relying on the coordination of several non-unitary working memory processes (e.g., storage and access to abstract representations, maintenance, cognitive inhibition of stimulus driven responses)[1]. Cohen *et al*. have suggested that a single deficit in context processing can account for the pattern of performance of schizophrenia subjects on three cognitive tasks: the Continuous Performance Test (CPT) [23, 24], the Stroop [25] colour-naming task [26, 27], and lexical disambiguation tasks [8, 28, 29]. A set of connectionist models has been shown to simulate normal and abnormal performance on these tasks on the basis of variations to a single parameter involving context processing.

Cohen and colleagues have thus argued that representations of context are necessary to support the processing of task–relevant information in the presence of competing sources of interference within each of these three tasks, despite contextual information taking on different forms in each task (i.e., context is encountered immediately prior to the target in the CPT, or can require the processing a *sequence* of prior stimuli as in reading, or may be intrinsic to each stimulus as in the Stroop task). Specifically, the performance of schizophrenia patients across tasks implies reduced context-dependent inhibition of pre-potent (inappropriate) responses. For example, schizophrenia patients tend to favour the strong meaning of an ambiguous word even when the weak meaning is implied by the semantic context created by the sentence [30, 31], and demonstrate a higher rate of false alarms on the CPT compared to healthy control subjects (reflecting reduced context-dependent inhibition of a "hit" response following presentation of a "no-hit" cue). Note that these findings implicate dysfunctional WM processes (i.e., failure to maintain contextual information) in the failure to inhibit inappropriate semantic associations, but do not implicate faulty *representations* of context that may be constructed prior to WM manipulation. We will return to this issue later with respect to social cognitive skills.

2.2.2. The Role of Long-Term Memory

According to Hemsley [5, 9, 32] and Gray [4, 33], the core cognitive disturbance in schizophrenia can be seen to reflect a weakening of the influence of stored memories or regularities of previous input on current perception. On this view, stored memories and/or learned heuristics represent contextual information that can be drawn upon in order to respond most effectively to incoming percepts, but the connections between past and current events are weakened in schizophrenia leading to context inappropriate responses. In a later formulation of the model, Hemsley [9] hypothesized that 'memories of past regularities' are stored but that the rapid and automatic access to such information, which is relevant for the evaluation of aspects of sensory input, is impaired (p. 101). The intrusion of sensory experiences of aspects of the environment not normally perceived or ambiguous sensory input and unexpected material from long-term memory cause the development of delusions and hallucinations.

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[1] Note that these tasks do not involve the active *construction* of context representations prior to manipulation by WM processes.

These proposed deficits in context processing have been linked to biological and neuropsychological models. Hemsley and Gray related the 'weakening of the influence of regularities of previous input on current perception' to behavioural models of latent inhibition and Kamin's blocking effect. Gray [4] emphasised the role of the hippocampus and related subcortical brain structures in accounting for deficient use of previously learned heuristics to guide behaviour. Gray argued that a failure in this function could be attributed to dopaminergic hyperactivity within the circuitry which regulates normal interaction between the hippocampus (*via* subiculum) to the nucleus accumbens and the mesolimbic system [4, 33].

3. CONTEXT PROCESSING AND SOCIAL COGNITION IN SCHIZOPHRENIA

Social cognition involves the perception, interpretation and processing of information related to the self, to others, and to interpersonal interactions [34]. Whilst there has been some speculation about the implications of poor context processing for social cognition and functioning in schizophrenia [8, 24], investigations of context processing to date have commonly employed non-social cognitive tasks reliant on WM processes associated with prefrontal cortex (PFC) activity [35] or perceptual grouping mechanisms in the primary visual cortex. In contrast, there has been little effort directed toward the investigation of context processing in relation to social cognitive tasks that may involve coordination of information from several brain regions (including uni-modal cortices, limbic and para-limbic structures, prefrontal cortex, and cerebellum).

Impairments in social cognition have long been considered a hallmark of schizophrenia [36]. Deficits in social cognition often precede the onset of overt psychotic symptoms [37], are useful to predict outcome [38], and represent a domain of functioning relatively independent of symptomatology [39]. Impaired social cognition in schizophrenia has been demonstrated across a range of distinct social-cognitive skills, using a variety of experimental paradigms. For example, schizophrenia patients demonstrate poor mental state inference - that is, the ability to infer others' mental states and intentions in order to predict behaviour [40], impaired perception of emotions from facial and prosodic cues [41], impaired social cue perception [42, 43] and biased reasoning about certain types of social information [44, 45].

3.1. Social Cognition and Neurocognitive Dysfunction in Schizophrenia

The relationship between deficits in social cognition and generalised neurocognitive dysfunction in schizophrenia remains unclear. Green and Neuchterlein [46] have endorsed the view that "basic neurocognition is a prerequisite for social cognition, and social cognition, in turn, is a prerequisite for social functioning." From this perspective, a generalised cognitive dysfunction should impact on social cognition, and in turn influence real-world social functioning. Similarly, Penn *et al*. [34] suggest that nonsocial cognition represents a necessary, but not sufficient condition for adequate social cognition. Thus, there may be distinct skills necessary to support effective social cognition over and above non-social information processing skills. Further support for this 'building block-view' of social cognition comes from a series of studies in which social cognition in schizophrenia patients was more strongly related to social functioning than with nonsocial cognition, indicating the relative specificity of social cognitive skills as distinct from generalised cognitive function, despite their potential commonalities [47].

Evidence in support of a direct relationship between neurocognitive dysfunction and social cognition comes from the New York High Risk Study [48] in which early detectable deficits in attention predicted social insensitivity and indifference in adulthood. More recent evidence indicates at least partial links between social-cognitive impairments in schizophrenia and basic neurocognitive deficits in attention [34, 49], memory [50] and executive functioning [51-53]. Neurocognitive dysfunctions in schizophrenia may thus impact upon social functioning at a later stage of development – i.e., during adolescence and early adulthood - when the variety and complexity of social input are likely to increase.

The proposal that deficient context processing may contribute to social-cognitive impairments in schizophrenia is consistent with the previously reported associations between generalised neurocognitive impairments and poor social cognition and functioning. We now turn to a review of the evidence for impaired social cognition in schizophrenia within various domains, including evidence from ToM and emotion perception. We will pay particular attention to the potential for context processing deficits to impact upon the skills required for effective social cognition in each of these domains.

3.2. Face Perception

Face perception is generally understood as a special instance of complex object processing that recruits a more 'holistic' (i.e., less part based) strategy of integrating the facial features into a global gestalt [54, 55]. The evidence for this view comes from studies showing that the recognition of faces and facial features is subject to more interruption by inversion than other objects, due to the breakdown of the facial gestalt [56]. Additional evidence implicates the salience of particular facial configurations in the perception of happiness [57], dominance [58], and threat [59-61].

Psychophysiological investigations of eye-movements have been useful in understanding the role of visual attention to various facial regions when extracting different types of information from faces. A visual scanpath is the pattern of eye movements used to process a complex stimulus, and provides an objective, real time measure of attention (Noton and Stark, 1971). Eye-movements to face stimuli follow a regular sequence, consisting of a triangular scanning pattern of fixations focusing on the primary features (eyes, nose and mouth) [59, 62, 63]. This visual scanning pattern represents an automatic, physiological response that may facilitate the integration of the attended feature areas into the facial gestalt.

3.2.1. Face Processing and Schizophrenia

Considerable evidence for impaired affect recognition in schizophrenia has accumulated in recent decades (see [67] for review). However, the neurocognitive underpinnings of facial affect processing impairments in schizophrenia remain elusive, and there have been null results reported in some studies [64, 65]. In addition, several studies suggest that there may be an exacerbated difficulty in recognising *negative* emotional states in schizophrenia [66-68], while other studies have not revealed robust support for this contention [41, 69].

3.2.2. Face Processing and Neurocognitive Deficits in Schizophrenia

If facial affect recognition impairments in schizophrenia stem from a generalized neurocognitive dysfunction in 'face processing' *per se*, this would predict concurrent impairments in identity recognition and age discrimination from face stimuli [70]. Indeed, there have been several instances of generalised face processing impairments (e.g., difficulty with identity recognition or judgments of age) reported alongside facial affect recognition deficits in schizophrenia [70-79].

Other neuropsychological investigations have implicated generalized memory deficits [80] and/or cognitive decline [76, 81] in generalised face processing difficulties in schizophrenia. There is also consistent evidence to suggest that specific deficits in facial affect and social cue recognition are related to dysfunctions in visual attention [52, 71, 82, 83] and verbal memory [71, 79, 84, 85], with the findings of [82, 83] in particular, implicating a role for early visual processing disturbances in facial affect perception deficits in schizophrenia.

The above findings are consistent with the idea that a core neurocognitive disturbance in early visual grouping may contribute to social cognitive impairments in schizophrenia. A fundamental impairment in coordinating information from facial elements to integrate the components into a coherent "whole-face" percept could conceivably account for impaired facial affect identification in schizophrenia, and would presumably impact upon age discrimination and identity recognition abilities as demonstrated in a number of studies (cited above).

3.2.3. Are faces Processed as Gestalts in Schizophrenia?

Both phenomenological and psychophysiological evidence supports the notion of a breakdown in gestalt processing of faces in schizophrenia. For example, psychotic patients experiencing the Capgras delusion will say that the face of the impostor 'looks' different, often with reference to a disruption in the overall gestalt quality of the face. For example, one schizophrenia patient describes the initial stages of her delusion in the following way [86]:

"I was seized with panic… I saw the individual features of her face, separated from each other: the teeth, then the nose, then the cheeks, then one eye and the other. Perhaps it was this independence of each part that…prevented my recognising her, even though I knew who she was." (p.11).

There is also evidence for distortions in the perception of faces in childhood, adolescent, and adult schizophrenia [87-90] both childhood and later onset schizophrenia, several forms of distortion (including total loss of the gestalt, as described above) have been observed. These distortions only occur when viewing a face from directly in front, but not when viewing profiles. Direct experimental evidence for the reduced influence of the facial gestalt over its component parts in schizophrenia comes from a study carried out over two decades ago [91]: subjects were asked to sort sets of schematic faces, nonsense objects, or histoforms (highly structured nonsense objects) into three groups, with each set composed of 15 objects made up of 5 independently varying features. The features of the face stimuli and nonsense objects could be integrated into a whole, but the histoforms could not. The distribution of four of the features was such that a set could be divided into three groups, while the fifth feature either remained constant (having no effect on sorting performance) or varied randomly (acting as a distractor). Healthy subjects sorted faces better than histoforms if no distractor was present, however, the presence of distractors impaired performance for faces but not histoforms. In schizophrenia patients, there was no advantage for sorting faces over histoforms, and the effect of distractor features was similar for every type of stimulus. Thus, the gestalt quality of the faces dominated over their details for healthy subjects, enabling more features to be handled at once (achieving better sorting with faces than histoforms, but also making it difficult to ignore a distracting component in the faces). However, the performance of the schizophrenia group suggests that the integrated gestalt of the face was not dominant over its components. The implications of this type of deficit for facial emotion processing in schizophrenia is far reaching given the often fleeting, and subtle muscle movements that require attention in order to accurately perceive facial expressions.

As raised earlier, faces evoke a consistent scanpath pattern of significantly more fixations (foveal attention) directed at the feature areas (eyes, nose, and mouths). In contrast, it has been consistently shown that schizophrenia patients fail to concentrate on feature areas of faces in visual scan path investigations during emotion perception and facial identity recognition tasks [92-96] (See Fig. **1**). Furthermore, schizophrenia patients have consistently demonstrated longer fixation durations, or 'staring' behaviour, that is consistent with the use of a controlled, sequential processing strategy, rather than an automatic parallel processing of the facial features. The evidence from eye-movements of schizophrenia patients is thus consistent with a dysfunction in pre-attentive grouping processes that would normally function to integrate facial features into an holistic face percept. Instead, there may be an abnormal emphasis on stimulus-driven sequential processing, such that 'irrelevant' (non-feature) facial areas are regarded as equally significant as feature regions.

3.3. Theory of Mind

The capacity to correctly infer another person's mental state in order to accurately predict their behaviour is commonly referred to as 'mentalizing' ability, or 'Theory-of-Mind' (ToM) [97]. The ability to attribute independent mental states to others, and to separate the content of another's implicit thoughts from their overt actions, has

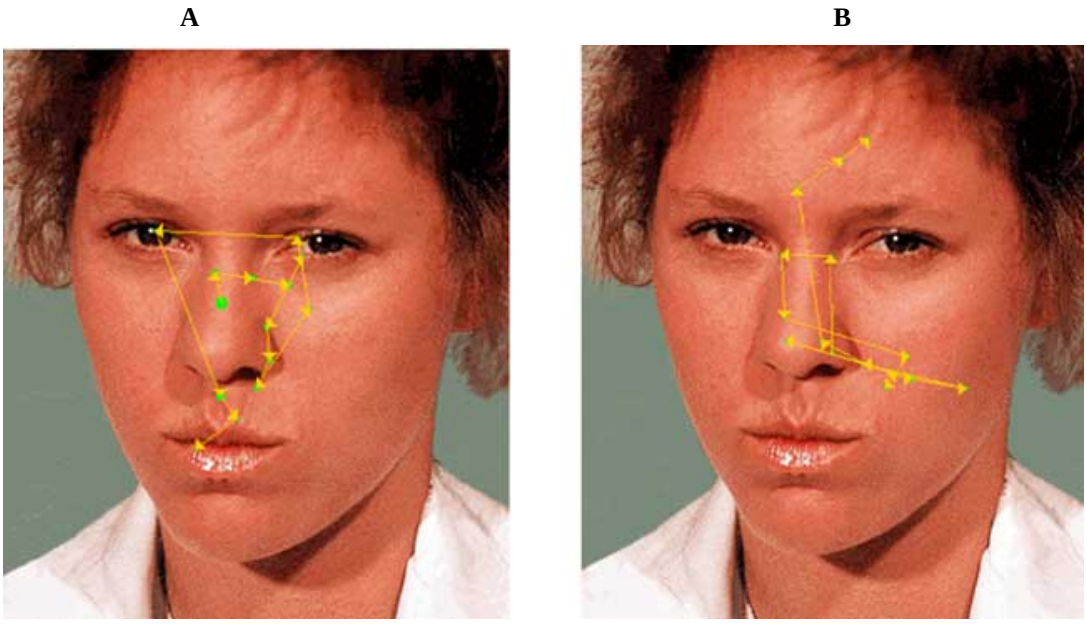

Fig. (1). Examples of visual scan paths to faces in a healthy (A) and a schizophrenia (B) participant.

been argued to provide many adaptive advantages in competitive social environments, such as a capacity to recognize deception, show empathy, predict how a person will behave on the basis of his/her mental states, manipulate another's knowledge, beliefs and/or intentions (in turn providing the capacity to persuade, deceive, and teach), and may also be seen to provide a context within which to judge the meaning of ambiguous communication (e.g., words, gestures) from conspecifics during social interaction.

3.3.1. Theory of Mind and Schizophrenia

Deficits in ToM were traditionally linked with interpersonal communication difficulties as observed in autism and Asperger syndrome [98-100], but have also been proposed to contribute to the development of both negative and positive symptoms of schizophrenia [40]. In support of these proposals, ToM impairments have been associated with positive [101-104] and disorganised or negative symptoms of schizophrenia [51, 105-107]. These deficits may contribute to the poor social functioning of schizophrenia patients. For example, [108] revealed that schizophrenia outpatients with higher levels of competence in making social inferences on ToM tasks had better overall community functioning than those who showed less ability in this aspect of social cognition.

3.3.2. Neurocognition, Mental State perception and Schizophrenia

Relatively little research has been carried out to examine the neurocognitive correlates of ToM deficits in schizophrenia. Two recent studies suggest that executive function (assessed on the basis of WCST performance) and verbal working memory are associated with impaired perception of *implicit* social information, one using Corocoran's [101] Hinting Task [51], and another using a measure of social cue perception from videos of actual social interactions [52]. This relationship is not surprising given that the Hinting Task and other standard measures of ToM depend heavily upon on the manipulation of verbal information in WM. However, executive functioning and memory deficits may only partially account for impaired social cognition in schizophrenia – indeed, WCST performance accounted for only 35% of the variance in social cue perception in the Lancaster *et al.* [52] study, whilst Greig *et al.* [51] report that a measure of thought disorder explained the majority of the variance in ToM performance (17%), with memory contributing to only 8% of the variance in social cognition. Furthermore, a study by Pickup and Frith [109] has demonstrated that ToM deficits remain in schizophrenia patients even after controlling for their poor recall performance in relation to items on the Hinting Task. It is therefore unlikely that verbal memory or working memory deficits can completely account for the observed ToM deficits in schizophrenia.

3.3.3. Context processing and Theory of Mind in Schizophrenia

Inferences about the intentions of other agents may be crucially dependent upon context-dependent information processing capacities. In particular, ToM deficits may reflect difficulty maintaining representations of context derived from verbal information, and/or difficulty constructing an appropriate representation of context from abstract visual information (such as gestures, or facial expressions). For example, a classic paradigm for the investigation of TOM ability is the 'Sally Anne Task' [98]. In this task, subjects must correctly interpret the meaning of visually presented drawings of social scenes, in order to represent and maintain the beliefs of two characters separately, as well as use this information to coordinate the actual state of affairs (The correct inference in this task therefore relies on the accurate formation and maintenance of context in WM, where contextual information takes the form of a subject's belief about a particular situation). This process of coordinating various mental processes in order to accurately represent the contents of another persons mental state is reflected in an early statement by Frith [110] (p.174) who suggested that theory of mind "can be seen as a cohesive interpretative

device par excellence: it forces together complex information from totally disparate sources".

3.3.4. ToM development and Context-Processing

Evidence from neuroimaging and psychophysiology support a relationship between context-dependent information processing and ToM. For example, the role of biological motion perception in the development, acquisition, and maintenance of ToM has been highlighted previously [111, 112]. Biological motion perception is a paradigmatic example of concurrent context-dependent processing, and can be studied with the use of a small number of light points which are strategically placed on an individuals' moving body [113]. An important feature of this paradigm is that no single dot conveys information about the object or event depicted; this can only be perceived as a function of integrating the individual signals across space and time. According to Blakemore and Decety [112], biological motion could serve as a basic mechanism for the attribution of intentions to agents, via simulation of the agent's actions within our own 'action-intention' architecture. From this perspective, context processing may be necessary for the development of cognitive precursors of ToM, which serve as the basis for more complex social-cognitive abilities. Impairments in context processing in schizophrenia may thus impact upon the acquisition of ToM skills early in development, but may impact upon social functioning at later stages of development when the variety and complexity of social interactions increases. A role for biological motion perception in the acquisition of ToM skills is further supported by evidence from developmental psychology**.** For example, it has been demonstrated that infants are able to distinguish biological (animate) motion from non-animate movements [114], and further, that 10-11-month-old infants are sensitive to the organization of intentional actions through simulation of the observed behaviour (i.e., automatically producing a 'copy' of the neural activation) of the person initiating and completing the intention [115]. These authors thus hypothesize that low-level perceptual mechanisms allow young infants to organize novel action sequences which serve as basic units upon which understanding of the intentions other agents is based (p.715). Thus, context-dependent processing of biological motion may be both relevant for the acquisition of ToM as well as the continual task of making inferences about the mental states of other people. It may not be surprising, then, to note that schizophrenia patients have shown deficient motion recognition [116-119]. The ability of schizophrenia patient to recognize biological motion from point-light displays (e.g., of facial expressions or body movements) thus deserves further attention.

3.3.5. ToM and Context Processing in Schizophrenia

There is recent evidence for a direct relationship between ToM deficits and concurrent context processing in perceptual organization. For example, a recent study examined relationships between performance on the Hinting Task [101], the Sally-Anne Task [98], the Eyes Test [120] and visual context processing in schizophrenia [17]. Visual context processing was measured with the Ebbinghaus Illusion - an example of the influence of concurrent visual context on perception where surrounding context circles induce a size distortion. In a previous series of studies [15, 121], both disorganized schizophrenia patients and schizotypal subjects showed a superior performance on this task as the result of their insensitivity to the surrounding visual context. In a further study, it was demonstrated that impaired ToM performance was significantly associated with enhanced size perception in schizophrenia patients, highlighting the possible link between ToM deficits and dysfunctional context processing in schizophrenia [17]. Similarly, Schenkel and Spaulding [122] examined the cognitive correlates of performance on the Hinting Task in schizophrenia patients with a contour integration task, a psychophysical paradigm assessing perceptual grouping in the primary visual cortex (V1), and the Hayling and Brixton Test [123], a task that is sensitive to linguistic-context processing. The results indicated that poor ToM in schizophrenia patients was related to both verbal and perceptual context-processing deficits. These studies provide preliminary support for an association between deficits in context processing and ToM impairments in schizophrenia.

Finally, a recent study revealed evidence for abnormal use of contextual information in schizophrenia across a range of social-cognitive tasks, some requiring ToM [124]. However, the pattern of performance across tasks did not support a simple interpretation of reduced social context processing in schizophrenia, and suggest that there may be different reasons why schizophrenia participants did not utilize social contextual information on different tasks. For example, the performance of schizophrenia patients suggested that they were distracted by contextual information when interpreting the mental state of videotaped actors, reflecting preoccupation with context rather than a *lack* of context processing on this particular task. Furthermore, on two of the social-cognitive tasks, neither schizophrenia nor control participants utilized contextual information effectively, raising doubts about the validity of these social-context processing measures. Nonetheless, Penn *et al.* did reveal some evidence for impaired social context processing in association with reduced social competence on the ward.

3.3.5. Face Perception and Theory of Mind

Information derived from facial expressions may influence the perception of mental states that are more complex than the basic emotions commonly studied in standard facial emotion paradigms, such as higher-order cognitive states (e.g., embarrassment, jealousy) and physical and mental intentions [125]. Studies in both healthy [120] and autistic children [125] have indeed demonstrated the significance of paying attention to particular facial features, such the eyes, for perceiving complex mental states. In addition, the reflexive orienting of attention in the direction of another person's gaze, or *deictic gaze* [126, 127] has been posited as a basis upon which more complex ToM skills may develop (see discussion in[128]. This is because deictic gaze entails the computation of what another person is *attending* to, a cognitive process known as 'shared attention'. Notably, there is evidence for the role of holistic processing in the perception of eye-gaze direction [129].

3.3.6. Perceiving Complex Mental States from Faces in Social Contexts

In real world settings, we rarely encounter faces in isolation. The impact of contextual information upon face

perception has been demonstrated in identity recognition tasks showing that changing the context from study to test phase significantly impairs recognition accuracy [130-132]. By contrast, relatively few studies have examined the influence of contextual cues upon the perception of *emotions* and/or *mental states* from information contained in facial expressions [128]. However, an increasing number of studies suggest that inferences about mental states evoked from facial expressions that are universally recognised as signals of specific emotions [133, 134] can be manipulated by various forms of contextual information.

For example, it has been shown that priming certain facial expressions with other emotional faces can influence the emotion perceived [135], and that even neutral faces can be judged as expressive in the context of clear emotional circumstances [136], or when primed with the presentation of emotional facial expressions [135]. In addition, Carroll and Russell [137] have shown that mental state attributions elicited by facial expressions can be manipulated by prefacing judgments with information to produce situationally based expectations. In their study, faces from the Ekman series depicting expressions of 'basic' emotions (surprise, anger, fear) were paired with vignettes describing situations that cued 'basic' (anger, fear, disgust) or 'non-basic' (hope, determination, confused, pain) emotional/mental states. Story-face pairs were designed to be discrepant in affective valence so that mental state judgments could be interpreted as reflecting the dominance of either situational context or visual information in the faces. The results revealed that situational information was used to determine the precise mental state or emotion inferred from the facial expression when the story and face were congruent in quasi-physical information, pleasure, and arousal levels. However, when facial and situational information were incongruent on these parameters, facial information took precedence over information derived from contextual information. Furthermore, situational information was especially influential when it suggested a non-basic emotion (e.g., a person in a painful situation but displaying a facial expression of "fear" was judged as "in pain"). These results were recently replicated, and a pilot study using a small sample of schizophrenia patients showed that they were unable to use contextual information when the story cued a higher-order mental state, rather than a basic emotional expression [138]. This finding suggests that complex social contextual information may be difficult for schizophrenia patients to integrate with target face percepts, but did not support a generalised deficit in social context processing, consistent with the Penn *et al.* (2002) study described in an earlier section.

A recent development in this area of research has involved the construction of a new task to examine the influence of social contextual information upon mental state perception: The Social Context Appreciation Task (SCAT; [139]. The SCAT consists of photographs depicting faces in isolation, each with a counterpart photo depicting the same face within a natural social setting; the inclusion of contextual information in the counterpart photograph is intended to qualify the interpretation of the facial expression, by providing a social scene within which to couch the face percept (See Fig. **2**). Thus, in this task, accurate perception of each character's mental state depends upon the ability to integrate information contained in the social context with that contained in the face. An important feature of the SCAT is that it affords examination of overt visual scanning strategies for naturalistic scene stimuli. Preliminary findings from a visual scanpath investigation using this task have revealed that schizophrenia participants pay less attention to contextual information when making mental state inferences about ambiguous faces [140]. That is, for photographs in which the healthy control subjects clearly directed visual attention to contextual features in order to clarify the meaning of an ambiguous expression, schizophrenia participants failed to demonstrate the same level of foveal attention to contextual information, such that their mental state judgements were based on information from the face alone, and were therefore often incorrect. Interestingly, however, this pattern of reduced context processing during mental state attribution in schizophrenia was not demonstrated across the entire series of faces; indeed the schizophrenia group demonstrated an opposing viewing strategy for naturalistic scenes in which the facial expression of the dominant character depicted fear (i.e., directing more visual attention to the surrounding context than the face itself). A speculative interpretation of this finding may be that for basic emotional expressions indicating a potential source of threat in the environment, schizophrenia patients are quick to judge the meaning of the facial expression and subsequently direct their attention to the impending source of threat. For ambiguous expressions, on the other hand, schizophrenia patients may become preoccupied with the ambiguous percept at the expense of attending to information in the environment that would serve to disambiguate the expression.

Collectively, these studies attest to the relative importance of social contextual information when interpreting the meaning of others' facial expressions. Whilst this idea has been previously raised – indeed, Ellis [141] proposed that contextual information may be necessary to discriminate between simple and complex mental states when judging the meaning of facial expressions – the significance of this process has so far been overlooked in studies of face processing disturbances in schizophrenia. In the context of paranoid delusions, for example, it is feasible to imagine the face of someone expressing "determination" (furrowed brow, pursed lips) being misinterpreted as an angry (personally threatening) face if social contextual information was not processed efficiently. Impairments in the ability to combine contextual information with local stimulus features when interpreting the meaning of the facial expressions may thus be relevant to clinical features of disorders such as schizophrenia, and possibly also depression.

3.4. Heterogeneity of Schizophrenia, Social Cognition and Context-Processing

A number of studies have indicated that deficits in visual context processing are not a general feature of schizophrenia, but are pronounced in patients with a history of poor premorbid social functioning [18, 142]. The association between poor premorbid functioning and dysfunctional visual context-processing could reflect a developmental trajectory where an initial failure to organize perceptual

Fig. (2.) Example stimuli for testing social contextual effects upon mental state perception.

sequences into meaningful units in complex social interactions leads to reduced social competence at an early age, which is expressed in the lack of significant social interactions characteristic of poor premorbid patients with schizophrenia. According to this view, during acute psychotic episodes, this ability to organize information breaks down further, as demonstrated by state-linked deficits in visual and thought organization [122]. In this study, poor social competence in childhood was related to both impaired verbal and non-verbal context processing as well as deficits in ToM.

Thus, perceptual organization ability has been associated with poorer premorbid and future functioning among schizophrenia patients. Impaired organization of information is thus characteristic of a subgroup of schizophrenia patients at an early age, but may only affect the organization of complex information such as that involved in social interactions.

4. SUMMARY, OUTLOOK, AND PROSPECTS

While deficits in the processing of contextual information have been related to multiple cognitive dysfunctions in schizophrenia and may constitute a core deficit of the disorder, the relevance of poor context processing for the understanding of social cognition in schizophrenia has been relatively overlooked. We have reviewed evidence to suggest that a basic deficit in context processing in schizophrenia may account for problems in interpreting and processing information in relation to the self to others, and to interpersonal interactions. While the data linking these two domains are preliminary, we nonetheless believe that the diverse evidence from developmental psychology, cognitive psychology and experimental psychopathology implicates context-dependent information processing in the acquisition, maintenance and execution of social-cognitive skills. These proposed links warrant further investigation, not only with respect to social cognitive deficits in schizophrenia, but also for an understanding of the emergence of social cognition during normal development.

In summary, we propose that deficits in context-processing in schizophrenia may also account for impairments in social cognition since (1) context processing is crucially involved the interpretation of social signals as demonstrated by the evidence from development psychology and face processing; (2) schizophrenia patients show aberrant visual scan paths in response to faces which are consistent with a deficit in integrating the individual features into a holistic percept;(3) deficits in context processing as assessed by several measures have been shown to be related to ToM and other social-cognitive deficits in schizophrenia; and (4) deficits in context processing are pronounced in schizophrenia patients with severe social-cognitive impairments which may reflect a developmental trajectory where deficits in context processing leads to reduced social competence at an early age.

An early deficit in the failure to group incoming percepts into meaningful social information may thus be elaborated into a failure to process context at a variety of levels within social cognitive tasks. For example, failure to determine an appropriate representation of context may be due to a basic perceptual difficulty in distinguishing the surrounding context from core stimulus; that is, reflecting biased focus of attention on low level stimulus features (i.e., bottom-up, featural processing) rather than higher level features of the stimulus (holistic representations). Evidence for early perceptual integration deficits thus suggest that context processing deficits in schizophrenia may be underpinned by an inability to initially *establish* an appropriate social context within which to couch subsequent responses; this basic failure to detect, or effectively establish context during initial perceptual processing may in turn account for deficits in the on-line selection of (encoded) material that is used to contextualise subsequent responses.

Our review highlights the need for further research examining the present conjectures about the role of context processing as an explanation for impairments in social cognition in schizophrenia, as well as its relevance for the understanding of the development of normal social cognition. Specifically, the evidence available linking dysfunctional context processing and impaired ToM in schizophrenia is limited to correlations between impaired

ToM and deficits on non-social cognitive tasks [17]. Additional studies need to demonstrate that dysfunctional context processing is more directly involved in ToM deficits by showing, for example, that strengthening contextual information can remediate ToM deficits (as per an earlier study in which strengthening contextual input was able to normalize impairments in visual context-processing in schizophrenia [143]). Moreover, further investigations should utilise new ToM tasks that include conditions in which mentalizing is dependent upon context processing abilities (as per the SCAT, described earlier). Performance on real-life mentalising tasks should therefore be considered in relation to neurocognitive indices of WM integrity, perceptual organization, behavioural and cognitive inhibition, autonomic arousal, symptom profile, and level of social and occupational functioning. Such research could enhance the relevance of the notion that deficits in context processing constitute a core disturbance in schizophrenia by showing that both social and non-social cognitive processes arise out of a common impairment.

The concurrent employment of psychophysiological indices of attention (i.e., eye-movements), electrophysiological measures of cortical functioning (Event-related potentials) and/or neuroimaging of the functional connectivity within deeper brain regions may be of interest in determining the status of specific context processing deficits as state- or trait- indicators of illness, and their contribution to social and interpersonal functioning. Research of this type is important for our knowledge of the neurocognitive basis of social cognition in schizophrenia, but may also aid the development of new strategies to improve interpersonal communication and occupational functioning in schizophrenia. Such intervention may be based on the remediation of context processing deficits through strengthening the salience of previously encountered, as well as concurrent, contextual information in order to facilitate improvements in social cognition in schizophrenia.

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5. REFERENCES

[1] Phillips WA, Silverstein SM. Convergence of biological and psychological perspectives on cognitive coordination in schizophrenia. Behavioral & Brain Sciences 2003; 26(1): 65-137.

[2] Cohen JD, Servan-Shreiber D. Context, cortex, and dopamine: A connectionist approach to behaviour and biology in schizophrenia. Psychological Review 1992; 99(1): 45-77.

[3] Shakow D. Segmental set: A theory of the formal psychological deficit in schizophrenia. Archives of General Psychiatry 1962; 6: 1-17.

[4] Gray JA, Feldon J, Rawlins JN, Hemsley DR, Smith AD. The neuropsychology of schizophrenia. Behavioral & Brain Sciences 1991; 14(1): 1-84.

[5] Hemsley DR. Perception and cognition in schizophrenia, in Schizophrenia: Origins, processes, treatment and outcome, R.L. Cromwell and C.R. Snyder, Editors; 1993, Oxford University Press: New York. pp; 135-150.

[6] Corrigan PW, Toomey R. Interpersonal problem solving and information processing deficits in schizophrenia. Schizophrenia Bulletin 1995; 21: 395-403.

[7] Penn DL, Spaulding W, Reed D, Sullivan M. The relationship of social cognition to ward behavior in chronic schizophrenia. Schizophrenia Research 1996; 20(3): 327-335.

[8] Cohen JD, Barch DM. Carter C, Servan-Schreiber D, Context-processing deficits in schizophrenia: Converging evidence from three theoretically motivated cognitive tasks. Journal of Abnormal Psychology 1999; 108(1): 120-133.

[9] Hemsley DR. A cognitive model for schizophrenia and its possible neural basis. Acta Psychiatrica Scandinavica 1994; 90(Suppl; 384): 80-86.

[10] Silverstein SM, Kovacs I, Corry R, Valone C. Perceptual organization, the disorganization syndrome and context processing in chronic schizophrenia. Schizophrenia Research 2000; 43(1): 11-20.

[11] Silverstein SM, Matteson S, Knight RA. Reduced top-down influence in auditory perceptual organization in schizophrenia. Journal of Abnormal Psychology 1996; 105(4): 663-667.

[12] Silverstein SM, Knight RA, Schwarzkopf SB, *et al*. Stimulus configuration and context effects in perceptual organization in schizophrenia. Journal of Abnormal Psychology 1996; 105(3): 410-420.

[13] Kovacs I. Gestalten of today: early processing of visual contours and surfaces. Behavioural Brain Research; 1996; 82(1): 1-11.

[14] Cox MD, Leventhal DB. A multivariate analysis and modification of a preattentive, perceptual dysfunction in schizophrenia. Journal of Nervous & Mental Disease 1978; 166(10): 709-718.

[15] Uhlhaas P, Silverstein SM, Phillips WA. Dysfunctional cognitive coordination in schizophrenia: Evidence from three theoretically motivated tasks. Schizophrenia Research 2003; 60: 184.

[16] Place EJ, Gilmore GC. Perceptual organization in schizophrenia. Journal of Abnormal Psychology 1980; 89(3): 409-418.

[17] Uhlhaas P, Silverstein, SM, Phillips WA, Schenkel L. Theory of mind and perceptual context processing in schizophrenia. Cognitive Neuropsychiatry 2005. under revision.

[18] Knight RA, Silverstein SM. The role of cognitive psychology in guiding research on cognitive deficits in schizophrenia: A process-oriented approach, in Origins and Developments of Schizophrenia. Advances in Experimental Psychopathology, R.H. M. F. Lenzenweger & Dworkin, Editor; 1998, American Psychological Association: Washington, DC. pp; 247-295.

[19] Silverstein SM, Bakshi S, Chapman RM, Nowlis G. Perceptual organisation of configural and nonconfigural visual patterns in schizophrenia: Effects of repeated exposure. Cognitive Neuropsychiatry 1998; 3(3): 209-223.

[20] Chey EYH, Holman P S. Perceptual organisation in schizophrenia: The employment of gestalt principles. Journal of Abnormal Psychology 1997; 106: 530-538.

[21] Knight RA, Manoach DS, Elliott DS, Hershenson M. Perceptual organization in schizophrenia: The processing of symmetrical configurations. Journal of Abnormal Psychology 2000; 109(4): 575-587.

[22] Cohen JD, Servan-Schreiber D. A theory of dopamine function and its role in cognitive deficits in schizophrenia. Schizophrenia Bulletin 1993; 19(1): 85-104.

[23] Servan-Schreiber D, Cohen JD, Steingard S. Schizophrenic deficits in the processing of context: A test of a theoretical model. Archives of General Psychiatry 1996; 53(12): 1105-1112.

[24] Stratta P, Daneluzzo E, Bustini M, Prosperini P, Rossi A. Processing of context information in schizophrenia: Relation to clinical symptoms and WCST performance. Schizophrenia Research 2000; 44(1): 57-67.

[25] Stroop JR. Studies of interference in serial verbal reactions. Journal of Experimental Psychology 1935; 18: 643-662.

[26] Abramczyk RR, Jordan DE, Hegel M. "Reverse" Stroop effect in the performance of schizophrenics. Perceptual & Motor Skills 1983; 56(1): 99-106.

[27] Wysocki JJ and Sweet JJ. Identification of brain-damaged, schizophrenic, normal medical patients using a brief neuropsychological screening battery. International Journal of Clinical Neuropsychology 1985; 7(1): 40-44.

[28] Bazin N, Perruchet P, Hardy-Bayle MC, Feline A. Context-dependent information processing in patients with schizophrenia. Schizophrenia Research 2000; 45(1-2): 93-101.

[29] Nestor PG, Kimble MO, O'Donnell BF, Smith L, *et al.* Aberrant semantic activation in schizophrenia: A neurophysiological study. American Journal of Psychiatry 1997; 154(5): 640-646.

[30] Chapman LJ, Chapman JP, Miller GA. A theory of verbal behaviour in schizophrenia, in Progress in experimental personality research, B.A. Maher, Editor; 1964, Academic Press: San Diego, CA. p; 135-167.

[31] Strauss ME. Strong meaning-response bias in schizophrenia. Journal of Abnormal Psychology 1975; 84(3): 295-298.

[32] Hemsley DR. An experimental psychological model for schizophrenia, in Search for the causes of schizophrenia., H. Hafner, W.F. Gattaz, W. Janzarick, Editors; 1987, Springer-Verlag: Heidelberg. p; 179-188.

[33] Gray JA, Joseph MH, Hemsley DR, *et al.* The role of mesolimbic domapinergic and retrohippocampal afferents to the nucleus accumbens in latent inhibition: implications for schizophrenia. Behavioural Brain Research 1995; 71: 19-31.

[34] Penn DL, Corrigan PW, Bentall RP, Racenstein JM, Newman L. Social cognition in schizophrenia. Psychological Bulletin 1997; 121(1): 114-132.

[35] Stuss DT, Levine B. Adult clinical neuropsychology: Lessons from studies of the frontal lobes. Annual Review of Psychology 2002; 53: 401-433.

[36] APA. Diagnostic and statistical manual of mental disorders (4th ed.); 1994, Washington, DC, USA: American Psychiatric Association. xxvii 886.

[37] Walker EF. Developmentally moderated expressions of the neuropathology underlying schizophrenia. Schizophrenia Bulletin 1994; 20: 453-480.

[38] Sullivan G. Marder SR., Liberman RP, Donahoe CP, Mintz J. Social skills and relapse history in outpatient schizophrenics. Psychiatry 1990; 53: 340–345.

[39] Lenzenweger MF, Dworkin RH. The dimensions of schizophrenia phenomenology: Not one or two, at least three, perhaps four. British Journal of Psychiatry 1996; 168(4): 432-440.

[40] Frith CD. The cognitive neuropsychology of schizophrenia. Essays in cognitive psychology; 1992, Hove, England UK: Lawrence Erlbaum Associates, Inc. xiv 169.

[41] Edwards J, Jackson HJ, Pattison PE. Emotion recognition via facial expression and affective prosody in schizophrenia: A methodological review. Clinical Psychology Review 2002; 22(6): 789-832.

[42] Corrigan PW, Wallace CJ, Green MF. Deficits in social schemata in schizophrenia. Schizophrenia Research 1992; 8(2): 129-135.

[43] Corrigan PW, Green MF, Toomey R. Cognitive correlates to social cue perception in schizophrenia. Psychiatry Research 1994; 53(2): 141-151.

[44] Dudley REJ, John CH, Young AW, Over DE. The effect of self-referent material on the reasoning of people with delusions. British Journal of Clinical Psychology 1997; 36(4): 575-584.

[45] Bentall R, Corcoran R, Howard R, Blackwood N, Kinderman P. Persecutory delusions: A review and theoretical integration. Clinical Psychology Review 2001; 21(8): 1143-1192.

[46] Green MF, Nuechterlein KH. Should schizophrenia be treated as a neurocognitive disorder? Schizophrenia Bulletin 1999; 25(2): 309-319.

[47] Ostrom TM. The sovereignty of social cognition., in Handbook of social cognition, R.S. Wyer and T.K. Srull, Editors; 1984, Erlbaum: Hillsdale, NJ. pp; 1-37.

[48] Erlenmeyer-Kimling L, Cornblatt BA. A summary of attentional findings in the New York High-Risk Project. Journal of Psychiatric Research 1992; 26(4): 405-426.

[49] Penn DL, Van der Does A, Spaulding WD, Garbin CP, *et al.* Information processing and social cognitive problem solving in schizophrenia: Assessment of interrelationships and changes over time. Journal of Nervous & Mental Disease 1993; 181(1): 13-20.

[50] Corrigan PW. The social perceptual deficits of schizophrenia. Psychiatry: Interpersonal & Biological Processes 1997; 60(4): 309-326.

[51] Greig TC, Bryson GJ, Bell MD. Theory of Mind Performance in Schizophrenia: Diagnostic, Symptom, Neuropsychological Correlates. Journal of Nervous & Mental Disease 2004; 192(1): 12-18.

[52] Lancaster RS, Evans JD, Bond GR, Lysaker PH. Social cognition and neurocognitive deficits in schizophrenia. Journal of Nervous & Mental Disease 2003; 191(5): 295-299.

[53] Addington J, Addington D. Neurocognitive and social functioning in schizophrenia: A 2.5 year follow-up study. Schizophrenia Research 2000; 44(1): 47-56.

[54] Farah MJ, Wilson KD, Drain M, Tanaka JM. What is special about face perception? Psychological Review 1998; 105(3): 482-498.

[55] Kanwisher N. Domain specificity in face perception. Nature Neuroscience 2000; 3(8): 759-763.

[56] Tanaka JW, Farah, MJ. Parts and wholes in face recognition. Quarterly Journal of Experimental Psychology. A, Human Experimental Psychology 1993; 46: 225-245.

[57] McKelvie SJ. Emotional expression in upside-down faces: Evidence for configurational and componential processing. British Journal of Social Psychology 1995; 34(3): 325-334.

[58] Senior C, Barnes J, Jenkins R, *et al.* Attribution of social dominance and maleness to schematic faces. Social behaviour and personality 1999; 27(4): 331-338.

[59] Green MJ, Williams LM, Davidson DJ. In the face of danger: Specific viewing strategies for facial expressions of threat? Cognition and Emotion 2003; 17(5): 779-786.

[60] Lundqvist D, Esteves F, Oehman A. The face of wrath: Critical features for conveying facial threat. Cognition & Emotion 1999; 13(6): 691-711.

[61] Matsumoto D. Face, culture, judgments of anger and fear: Do the eyes have it? Journal of Nonverbal Behavior 1989; 13(3): 171-188.

[62] Groner R, Walder F, Groner M, Looking at faces: Local and global aspects of scanpaths, in Theoretical and Applied Aspects of Eye Movement Research, A. Gale G, and F. Johnson, Editors; 1984, Elsevier Science: North Holland. p; 523-533.

[63] Walker-Smith GJ, Gale AG, Findlay JM. Eye movement strategies involved in face perception. Perception 1977; 6: 313-326.

[64] Bellack AS, Blanchard JJ, Mueser KT. Cue availability and affect perception in schizophrenia. Schizophrenia Bulletin 1996; 22(3): 535-544.

[65] Flack WFJC, Lorraine A, Laird James D, Miller Daniel R. Accurate encoding and decoding of emotional facial expressions in schizophrenia. Psychiatry: Interpersonal & Biological Processes 1997; 60(3): 197-210.

[66] Bellack AS, Mueser KT, Wade J, Sayers S, Morrison RL. The ability of schizophrenics to perceive and cope with negative affect. British Journal of Psychiatry; 1992; 160: 473-480.

[67] Edwards J, Pattison PE, Jackson HJ, Wales RJ. Facial affect and affective prosody recognition in first-episode schizophrenia. Schizophrenia Research 2001; 48(2-3): 235-253.

[68] Morrison RL, Bellack AS, Bashore TR. Perception of emotion among schizophrenic patients. Journal of Psychopathology & Behavioral Assessment 1988; 10(4): 319-332.

[69] Zuroff DCC, Sally A. Emotion recognition in schizophrenic and depressed inpatients. Journal of Clinical Psychology 1986; 42(3): 411-417.

[70] Kerr SL, Neale JM. Emotion perception in schizophrenia: Specific deficit or further evidence of generalised poor performance? Journal of Abnormal Psychology 1993; 102(2): 312-318.

[71] Addington J, Addington D. Facial affect recognition and information processing in schizophrenia and bipolar disorder. Schizophrenia Research 1998; 32(3): 171-181.

[72] Archer J, Hay DC, Young AW. Face processing in psychiatric conditions. British Journal of Clinical Psychology 1992; 31(1): 45-61.

[73] Borod JC, Martin CC, Alpert M, Brozgold A, Welkowitz J. Perception of facial emotion in schizophrenic and right brain-damaged patients. Journal of Nervous & Mental Disease 1993; 181(8): 494-502.

[74] Feinberg TE, Rifkin A, Schaffer C, Walker E. Facial discrimination and emotional recognition in schizophrenia and affective disorders. Archives of General Psychiatry 1986; 43(3): 276-279.

[75] Gessler S, Cutting J, Frith CD, Weinman J. Schizophrenic inability to judge facial emotion: A controlled study. British Journal of Clinical Psychology 1989; 28(1): 19-29.

[76] Mueser KT, Penn DL, Blanchard JJ, Bellack AS. Affect recognition in schizophrenia: A synthesis of findings across three studies. Psychiatry: Interpersonal & Biological Processes 1997; 60(4): 301-308.

[77] Novic J, Luchins DJ, Perline R. Facial affect recognition in schizophrenia:Is there a differential deficit? British Journal of Psychiatry 1984; 144: 533-537.
[78] Salem JE, Kring AM, Kerr SL. More evidence for generalized poor performance in facial emotion perception in schizophrenia. Journal of Abnormal Psychology 1996; 105(3): 480-483.
[79] Schneider F, Gur RC, Gur RE, Shtasel DL. Emotional processing in schizophrenia: Neurobehavioral probes in relation to psychopathology. Schizophrenia Research 1995; 17(1): 67-75.
[80] Hellewell JSE, Connell J, Deakin JFW. Affect judgement and facial recognition memory in schizophrenia. Psychopathology 1994; 27(3-5): 255-261.
[81] Mueser KT, Doonan R, Penn DL, *et al.* Emotion recognition and social competence in chronic schizophrenia. Journal of Abnormal Psychology 1996; 105(2): 271-275.
[82] Kee KS, Kern RS, Green MF. Perception of emotion and neurocognitive functioning in schizophrenia: What's the link? Psychiatry Research 1998; 81(1): 57-65.
[83] Sergi MJ, Green MF. Social perception and early visual processing in schizophrenia. Schizophrenia Research 2002; 59: 233-241.
[84] Kohler CG, Bilker W, Hagendoorn M, Gur RE, Gur RC. Emotion recognition deficit in schizophrenia: Association with symptomatology and cognition. Biological Psychiatry 2000; 48: 127-136.
[85] Mandal MK, Palchoudhury S. Decoding of facial affect in schizophrenia. Psychological Reports 1985; 56(2): 651-652.
[86] Conroy F, Autobiography of a schizophrenic girl; 1951, NY, USA.: Penguin.
[87] Berndl K, Grusser OJ, Martin M, Remschmidt H. Comparative studies on recognition of faces, mimic and gestures in adolescent and middle-aged schizophrenic patients. European Archives of Psychiatry and Neurological Science 1986; 236(2): 123-130.
[88] Berndl K, von Cranach M, Grusser OJ. Impairment of perception and recognition of faces, mimic expression and gestures in schizophrenic patients. European Archives of Psychiatry and Neurological Science 1986; 235(5): 282-291.
[89] Berndl K, Dewitz W, Grusser OJ, Kiefer RH. A test movie to study elementary abilities in perception and recognition of mimic and gestural expression. European Archives of Psychiatry and Neurological Science 1986; 235(5): 276-281.
[90] Dewdney D. A specific distortion of the human facial percept in childhood schizophrenia. Psychiatric Quarterly 1973; 47(1): 82-94.
[91] Frith CD, Stevens M, Johnstone EC, Owens DGC, Crow TC. Integration of schematic faces and other complex objects in schizophrenia. Journal of Nervous & Mental Disease 1983; 171(1): 34-39.
[92] Green MJ, Williams LM, Davidson DJ. Visual scanpaths to threat-related faces in deluded schizophrenia. Psychiatry Research 2003; 119(3): 271-285.
[93] Loughland CM, Williams LM, Gordon E. Visual scanpaths to positive and negative facial emotions in an outpatient schizophrenia sample. Schizophrenia Research 2002; 55: 159-170.
[94] Williams LM, Loughland CM, Gordon E, Davidson D. Visual scanpaths in schizophrenia: Is there a deficit in face recognition? Schizophrenia Research 1999; 40(3): 189-199.
[95] Phillips ML, David AS. Visual scan paths are abnormal in deluded schizophrenics. Neuropsychologia 1997; 35(1): 99-105.
[96] Phillips ML, Howard R, David AS. A cognitive neuropsychological approach to the study of delusions in late-onset schizophrenia. International Journal of Geriatric Psychiatry 1997; 12(9): 892-901.
[97] Premack D, Woodruff G. Does the chimpanzee have a theory of mind? Behavioral & Brain Sciences 1978; 1(4): 515-526.
[98] Baron-Cohen S, Leslie AM, Frith U. Does the autistic child have a "theory of mind"? Cognition 1985; 21(1): 37-46.
[99] Happe F. Autism: An introduction to psychological theory; 1994, Cambridge, MA, US: Harvard University Press.
[100] Frith U, ed. Autism and Asperger syndrome; 1991, Cambridge University Press: New York, NY, US.
[101] Corcoran R, Mercer G, Frith CD. Schizophrenia, symptomatology and social influence: Investigating "theory of mind" in people with schizophrenia. Schizophrenia Research 1995; 17(1): 5-13.
[102] Corcoran R, Frith CD. Conversational conduct and the symptoms of schizophrenia. Cognitive Neuropsychiatry 1996; 1(4): 305-318.
[103] Corcoran R, Cahill C, Frith CD. The appreciation of visual jokes in people with schizophrenia: A study of 'mentalizing' ability. Schizophrenia Research 1997; 24(3): 319-327.
[104] Frith CD, Corcoran R. Exploring 'theory of mind' in people with schizophrenia. Psychological Medicine 1996; 26(3): 521-530.
[105] Langdon R, Coltheart M. Mentalising, schizotypy, schizophrenia. Cognition 1999; 71(1): 43-71.
[106] Langdon R, Coltheart M, Ward PB, Catts SV. Mentalising, executive planning and disengagement in schizophrenia. Cognitive Neuropsychiatry 2001; 6(2): 81-108.
[107] Sarfati Y, Hardy-Bayle M, Besche C, Widlocher D. Attribution of intentions to others in people with schizophrenia: a non-verbal exploration with comic strips. Schizophrenia Research 1997; 25: 199-209.
[108] Roncone R, Falloon IR, Mazza M, *et al.* Is theory of mind in schizophrenia more strongly associated with clinical and social functioning than with neurocognitive deficits? Psychopathology 2002; 35(5): 280-288.
[109] Pickup GJ, Frith CD. Theory of mind impairments in schizophrenia: Symptomatology, severity and specificity. Psychological Medicine 2001; 31(2): 207-220.
[110] Frith C, Done J. Positive symptoms of schizophrenia. British Journal of Psychiatry 1989; 154: 569-570.
[111] Jarrold C, Butler DW, Cottington EM, Jiminez F. Linking theory of mind and central coherence in autism and in the general population. Developmental Psychology 2001; 36: 126-138.
[112] Blakemore SJ, Decety J. From the perception of action to the understanding of intention. Nature Reviews Neuroscience 2001; 2(8): 561-7.
[113] Johansson G. Visual perception of biological motion. Perception & Psychophysics 1973; 14: 201-211.
[114] Gelman S, Spelke E. The development of thoughts about animate and inanimate objects: Implications for research on social cognition., in Social Cognitive Development, J.F.L. Ross, Editor; 1981, Cambridge University Press: Cambridge. p.
[115] Baldwin DA, Baird, JA, Saylor MM, Clark, MA. Infants parse dynamic action. Child Development 2001: 708-717.
[116] Chen Y, Nakayama K, Levy D, Matthysse S, Holzman P. Processing of global, but not local, motion direction is deficient in schizophrenia. Schizophrenia Research 2003; 61(2-3): 215-227.
[117] Brenner CA, Wilt MA, Lysaker PH, Koyfman A, O'Donnell BF. Psychometrically matched visual-processing tasks in schizophrenia spectrum disorders. Journal of Abnormal Psychology 2003; 112(1): 28-37.
[118] Brenner CA, Lysaker PH, Wilt MA, O'Donnell BF. Visual processing and neuropsychological function in schizophrenia and schizoaffective disorder. Psychiatry Research 2002; 111(2-3): 125-136.
[119] Li C-SR, Impaired detection of visual motion in schizophrenia patients. Progress in Neuro-Psychopharmacology & Biological Psychiatry 2002; 26(5): 929-934.
[120] Baron-Cohen S, Cross P. Reading the eyes: Evidence for the role of perception in the development of a theory of mind. Mind & Language 1992; 7(1-2): 172-186.
[121] Uhlhaas PJ, Silverstein, SM, Phillips, WA, Lovell, PJ. Schizotypy, thought disorder and visual context. Schizophrenia Research, in press.
[122] Schenkel LS, Spaulding WD. Social inference in schizophrenia: Relationships with childhood functioning and later cognitive impairment. in 17th annual meeting of the Society for Research in Psychopathology; 2002. San Francisco, CA.
[123] Burgess PW, Shallice T. The Hayling and Brixton Tests; 1997, Thames Valley Test Company: Edmunds, UK.
[124] Penn DL, Ritchie M, Francis J, Combs D, Martin J. Social perception in schizophrenia: the role of context. Psychiatry Research 2002; 109(2): 149-159.
[125] Baron-Cohen S, Campbell R, Karmilloff-Smith A, Grant J, Walker J. Are children with autism blind to the mental significance of the eyes. British Journal of Developmental Psychology 1995; 13: 379-398.
[126] Bruner J. Child's talk: Learning to use language; 1983, Oxford: Oxford University Press.
[127] Driver J, Davis G, Ricciardelli P, *et al.* Gaze perception triggers reflexive visuospatial orienting. Visual Cognition 1999; 6(5): 509-540.
[128] Baron-Cohen S. Theory of mind and face-processing: How do they interact in development and psychopathology?, in

Developmental psychopathology, Vol; 1: Theory and methods. Wiley series on personality processes., D. Cicchetti and D.J. Cohen, Editors; 1995, John Wiley & Sons: New York, NY, USA. p; 343-356.

[129] Jenkins J, Langton, SRH. Configural processing in the perception of eye-gaze. Perception 2003; 32(1181-1188).

[130] Davies G, Milne A. Recognizing faces in and out of context. Current Psychological Research 1982; 2(4): 235-246.

[131] Winograd E, Rivers-Bulkeley NT. Effects of changing context on remembering faces. Journal of Experimental Psychology: Human Learning & Memory 1977; 3(4): 397-405.

[132] Watkins MJ, Ho E, Tulving E. Context effects in recognition memory for faces. Journal of Verbal Learning & Verbal Behavior 1976; 15(5): 505-517.

[133] Ekman P. Universals and cultural differences in facial expressions of emotion. Nebraska Symposium on Motivation 1971: 207-283.

[134] Ekman P, Friesen W. The pictures of facial affect; 1976, Consulting Psychologists Press: Palo Alto, CA.

[135] Tanaka-Matsumi J, Attivissimo D, Nelson S, D'Urso T. Context effects on the judgment of basic emotions in the face. Motivation & Emotion 1995; 19(2): 139-155.

[136] Carrera-Levillain P, Fernandez-Dols J-M. Neutral faces in context: Their emotional meaning and their function. Journal of Nonverbal Behavior 1994; 18(4): 281-299.

[137] Carroll JM, Russell JA. Do facial expressions signal specific emotions? Judging emotion from the face in context. Journal of Personality & Social Psychology 1996; 70(2): 205-218.

[138] Green MJ, Waldron, JH. Reduced appreciation of social context in schizophrenia impairs the perception of complex mental states. Schizophrenia Research 2004; 164.

[139] Green MJ, Waldron, JH, Coltheart, M. Social context effects on the perception of ambiguous faces: Introducing the Social Context Appreciation Task (SCAT). in preparation.

[140] Green MJ, Waldron, J.H, Coltheart, M. Mental state perception in schizophrenia: the role of social context. Neuropsychology? 2004. INS conference proceedings.

[141] Ellis HD and Young AW. Faces in their social and biological context, in Face and mind. Oxford cognitive science series., A.W. Young, Editor; 1998, Oxford University Press: New York, NY, USA. p; 67-95.

[142] Knight RA. Converging models of cognitive deficit in schizophrenia, in Theories of schizophrenia and psychosis, W.D.S.J.K. Cole, Editor; 1984, University of Nebraska Press: Lincoln. p.

[143] Silverstein SM, Osborn LM, West LL, Knight RA. Perceptual organisation in schizophrenia: Evidence of intact processing of configural stimuli. Cognitive Neuropsychiatry 1998; 3(3): 225-235.

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