Facial emotion recognition from moving and static point-light images in schizophrenia

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Abstract

It is well established that schizophrenia is associated with difficulties recognising facial expressions of emotion. It has been suggested that this impairment could be specific to moving faces [Archer, J., Hay, D., Young, A., 1994. Movement, face processing and schizophrenia: evidence of a differential deficit in expression analysis. British Journal of Clinical Psychology, 33, 517–528]. The current study used point-light images to assess whether people with schizophrenia can interpret emotions from isolated patterns of facial movement in the absence of featural cues. Emotion recognition from moving and static images was assessed using a forced choice design with two sets of three emotions (anger, sadness and surprise; disgust, fear and happiness). The schizophrenia group was significantly better at recognising the emotions from moving images than static images. Although the control group was more accurate overall than the schizophrenia group, both groups presented the same characteristic patterns of performance across tasks. For example, in terms of which emotions were better recognised than others and the types of misidentifications that were made. Hence, it is concluded that people with schizophrenia are sensitive to the motion patterns which underlie individual expressions of emotion and can use this information to accurately recognise emotions.

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1. Introduction

Schizophrenia has been consistently associated with an impairment in the ability to perceive other people’s facial expressions of emotion (e.g., Addington and Addington, 1998; Dougherty et al., 1974;
Feinberg et al., 1986; Kerr and Neale, 1993; Walker et al., 1980) and this is likely to be a determinant of the characteristic difficulties in social functioning that are a hallmark for schizophrenia. Indeed, deficits in affect perception have been directly related to poor social functioning and behaviour in schizophrenia (Hooker and Park, 2002; Mueser et al., 1996; Penn et al., 2000; Poole et al., 1997).

Many research studies have investigated the nature of this emotion recognition deficit to ascertain whether factors like medication, stage of illness and symptom profile mediate the impairment. Although difficulties with affect perception appear to be exacerbated during acute psychotic episodes, they are also present during periods of remission (Gessler et al., 1989). That is, the impairment has been found to remain stable over time (Addington and Addington, 1998) and is present in first-episode patients (Edwards et al., 2001), as well as chronic patients (Mueser et al., 1996). Moreover, adults, children and adolescents with schizophrenia (Walker et al., 1980) and the first-degree relatives of people with schizophrenia (Tookey et al., 1999) have all been shown to recognise emotion less accurately than non-patient controls. Furthermore, the deficit cannot be explained as being related to antipsychotic medication usage as this impairment has been presented in unmedicated samples (Kerr and Neale, 1993), it appears to be unaffected by traditional antipsychotic medication (Gaebel and Wolfer, 1992) and can even be improved by atypical antipsychotics (Kee et al., 1998). Nevertheless, people with schizophrenia are still impaired in emotion recognition compared to other psychiatric populations (Archer et al., 1992).

The underlying cause of this deficit remains uncertain. There are three possible explanations for the level at which the impairment manifests itself. First, it has been proposed that the decline in emotion recognition accuracy reflects a specific emotion recognition deficit in schizophrenia (e.g., Archer et al., 1994; Dougherty et al., 1974; Gaebel and Wolfer, 1992; Mueser et al., 1996; Muzekari and Bates, 1977; Novic et al., 1984; Silver et al., 2002; Walker et al., 1984). Alternatively, this emotion recognition deficit could be an artefact of a generalised face-processing impairment, which is supported by studies that have found people with schizophrenia to be impaired on all face-processing tasks (e.g., Archer et al., 1992; Johnston et al., 2001; Kerr and Neale, 1993; Salem et al., 1996). Finally, all these difficulties could be related to more global cognitive impairments associated with schizophrenia that are not selective to faces or emotion (e.g., Bryson et al., 1997; Kohler et al., 2000). There are manifold reasons for there being little conclusive evidence to define the underlying cause of the deficit. These most commonly pertain to methodological weaknesses and variability across tasks and studies that make it impossible to differentiate between the three levels of impairment and also make comparisons across studies of little consequence.

However, two studies by Archer and colleagues (1992, 1994) that were identical in method and design, but differed in terms of whether the stimuli were viewed moving or static, found conflicting results regarding the specificity of the emotion recognition deficit in schizophrenia. First, a comparison of emotion recognition with two non-emotional face-processing tasks, using static facial stimuli, showed that people with schizophrenia performed less accurately than both a depressed and non-psychiatric control group (Archer et al., 1992). This was reported as evidence for a generalised face-processing deficit. However, when the same tasks were re-developed with dynamic facial stimuli, the schizophrenia group demonstrated an even greater decrease in accuracy compared to both control groups, but only on the emotional task and not the control tasks. Consequently, Archer et al. (1994) proposed that schizophrenia is associated with an emotion recognition deficit specific to moving faces.

This finding could have serious implications for the understanding of schizophrenia, both in terms of social functioning and possible neuropsychological impairment. First, in everyday life situations faces are nearly always moving and therefore experimental tasks utilising dynamic stimuli arguably re-create more realistic simulations of everyday emotion perception. Hence, being unable to use this information to make appropriate decisions regarding other people’s current emotional states could directly influence the social difficulties people with schizophrenia regularly experience. Second, evidence from people with acquired brain-damage has demonstrated that there is a double dissociation between the ability to recognise facial emotions from moving and static
images (Humphreys et al., 1993). That is, it is possible for one, or the other, process to be impaired while the other is unaffected. Therefore, should it be confirmed that schizophrenia is associated with a specific emotion recognition deficit selective to moving images; this would imply that a particular part of the brain may be selectively affected by schizophrenia.

The point-light (PL) imaging technique, originally pioneered by Johansson (1973), can be used to isolate biological movement in the absence of cues from features and form. Dynamic images can be made that comprise only white dots moving against a black background that represent the motion patterns involved in different actions. The advantage of using this technique is that it specifically examines movement perception. When standard full-light images are used the information present in a static image is essentially also available in a moving image. This means that when viewing a dynamic image the information from the movement itself may not necessarily be contributing to the judgment being made. Indeed, as accuracy levels for judging emotional expressions from static images are typically so high, in the non-clinical population, it has been difficult to demonstrate an advantage for viewing expressions moving rather than static. However, studies that have used the PL technique have demonstrated that emotions can be recognised at levels significantly greater than chance from moving PL images but at close to chance levels in the static condition. This is due to the poverty of the information available in the static PL images (e.g., Bassili, 1978, 1979; Bruce and Valentine, 1988). This confirms that we are sensitive to the motion patterns that underlie facial expressions of emotion and can use this information when in isolation to accurately perceive different emotions.

Point-light images were created to directly examine emotion recognition from moving and static images in schizophrenia. It was hypothesised that should there be a specific deficit in emotion recognition from moving images, as found by Archer et al. (1994), then the schizophrenia group in the current study would be expected to show little to no advantage for viewing the PL images moving rather than static. This would be demonstrated at chance level performance on the moving conditions. In contrast, a significant improvement in accuracy by the schizophrenia group, when the images are moving compared to static would imply that they are sensitive to emotional movement information. This finding would suggest that the processes involved in the perception of moving emotional expressions are not selectively impaired in schizophrenia. Therefore implying that it is not movement that is impeding performance in the emotion recognition study of Archer et al. (1994).

A pilot study was conducted where unimpaired participants had to assign emotional labels to the point-light images. Six different emotions were presented and participants had to choose the correct label for each image. Non-psychiatric participants found this task very hard, scoring only just above chance. In the anticipation that the schizophrenia participants would find the task even more difficult, the current study employed methodology whereby the six emotions were divided into two subsets of three emotions. An analysis of misidentifications with PL images showed that these corresponded to confusions noted by Young et al. (1997) in the development of the Emotional Hexagon. In order to reduce these confusions and so to improve the participants performance, the set of six emotions was divided into two subsets of three emotions (Set 1: anger, sadness and surprise; Set 2: disgust, fear and happiness) that were presented to participants separately. The composition of each subset was intended to eliminate common misidentifications (e.g. anger and disgust, fear and surprise).

2. Method

2.1. Participants

16 people (12 males) with a confirmed DSM-IV diagnosis of schizophrenia were recruited through the Birmingham and Solihull Mental Health Trust. They were aged between 24 and 59 years of age (mean 34.88 years). All provided written consent before commencing the study. Clinical assessments using the Brief Psychiatric Rating Scale (BPRS: Overall and Gorham, 1962) showed that the group had a mean BPRS score of 35.4 (standard deviation 7.4). The control group comprised of 24 students (21 females) from the University of Birmingham aged between 18 and 24 (mean 19.65 years).
2.2. Design

The experiment had a 2 (Group; Experimental, Control) × 2 (Image type; Moving, Static) × 2 (Emotion set; Set 1; anger, sadness, surprise, Set 2; disgust, fear, happy) mixed design with Group as the only between-subjects factor. All participants completed all four tasks (Moving emotion set 1 condition, Moving emotion set 2 condition, Static emotion set 1 condition, Static emotion set 2 condition). The order in which conditions were carried out was counterbalanced across participants with the restraint that conditions of the same Image type (e.g., two moving conditions) were carried out in succession. For each condition there were two predetermined trial orders, which had been arranged so that the same emotion did not appear more than twice in succession. Participants carried out one order for each condition.

2.3. Stimuli

72 moving point-light images were created using Pro-Reflex Motion Capture system. These consisted of 12 actors (6 male) expressing 6 emotions (anger, disgust, fear, happiness, sadness and surprise). Each actor had 72 light-emitting markers attached to their face in a set distribution pattern and was filmed at a rate of 30 Hz. The expression began with a neutral pose and moved into the full emotion in one second. The static images were single frames taken from the peak of each corresponding video image (see Fig. 1).

2.4. Procedure

Participants were tested individually in a quiet room. A practice session with 6 trials was carried out before commencing each condition. In the moving conditions, each trial consisted of the image repeating three times (Bassili, 1978), with a clear break between each repetition to emphasise the start of the expression. Each repetition lasted one second, so participants were exposed to a total of three seconds worth of each moving image. This was followed by a blank screen directing the participant to circle their response from the choice of three on their response sheet. After a maximum duration of ten seconds the computer beeped to alert the participant that the next trial was about to begin. However, participants could move

![Fig. 1. Examples of static frames taken from the point-light images of one actor.](image-url)
themselves on as soon as they were ready after the image had finished playing and within the ten second blank screen interval. There were 36 trials in each condition. The static conditions followed the same format, but the image remained on the screen for three seconds before the blank ten second response screen appeared.

3. Results

3.1. Comparison of performance for each condition

The sum of correct responses was calculated for each participant for each condition. The mean accuracy scores for each group (schizophrenia, \( N = 16 \); control, \( N = 24 \)) and each condition are presented in Fig. 2. Both groups presented the same pattern across tasks in terms of which conditions were more accurately completed. A 2 (Group; schizophrenia, control) x 2(Image Type; moving, static) x 2(Emotion; set 1, set 2) mixed ANOVA was carried out with Group as the only between-subjects factor.

There was a significant main effect of Group, \( (F(1, 38) = 35.4, p < 0.001) \), overall the control group was more accurate than the schizophrenia group. A significant main effect of Image Type \( (F(1, 38) = 323.1, p < 0.001) \) confirmed that moving images were better recognised than static images and a significant main effect of Emotion Set \( (F(1, 38) = 81.7, p < 0.001) \) highlighted that the Emotion set 1 images (anger, sad, surprise) were more accurately recognised than the Emotion set 2 images (disgust, fear, happy). A 2-way interaction between Image Type and Group \( (F(1, 38) = 23.6, p < 0.0001) \) showed that although the control group was significantly more accurate on the moving tasks compared to the schizophrenia group, there was no difference between groups on the static conditions.

These effects were modified by a 3-way interaction between, Group, Image Type and Emotion Set \( (F(1, 38) = 34.5, p < 0.05) \). However, post hoc analyses showed that the comparisons between Group, Image Type and Emotion Set that were causing this interaction were not meaningful in relation to the purpose of this experiment.

3.2. Analysis by individual emotions

A second analysis examined levels of accuracy for individual emotions and the nature of misidentifications for each emotion set. Total accuracy scores for each emotion were calculated and misidentifications were coded. The mean number of response types (e.g., one correct response and two possible misidentifications) for each individual emotion is presented by Group and Image Type in Fig. 3.

3.2.1. Analysis emotion set 1

3.2.1.1. Overall analysis by emotion, image type and group. A 3 (Emotion; anger, sad, surprise) x 2 (Image Type; Moving, Static) x 2 (Group; Schizophrenia, Control) repeated measures ANOVA with Group as the only between-subjects factor was carried out. A significant main effect of Image Type, \( (F(1, 38) = 201.7, p < 0.001) \) confirmed that moving images were more accurately recognised than static images, for all emotions. There was also a significant main effect of Emotion \( (F(1, 38) = 81.7, p < 0.001) \) highlighted that the Emotion set 1 images (anger, sad, surprise) were more accurately recognised than the Emotion set 2 images (disgust, fear, happy). A 2-way interaction between Image Type and Group \( (F(1, 38) = 23.6, p < 0.0001) \) showed that although the control group was significantly more accurate on the moving tasks compared to the schizophrenia group, there was no difference between groups on the static conditions.

There was a significant main effect of Group \( (F(1, 38) = 22.8, p < 0.001) \), and there was a trend towards an interaction between Image Type and Group \( (F(1, 38) = 3.07, p = 0.088) \). Again analysis using Tukey’s HSD showed that there were no differences between groups on the static emotions.
Fig. 3. Mean responses for each emotion category, by each possible response.
(p<0.99) but a trend towards the control group being more accurate than the schizophrenia group on the moving emotions (p=0.09) in this condition.

### 3.2.1.2. Analysis of responses to individual emotions by image type and group

Post hoc analysis using Tukey’s HSD compared responses to individual emotions within groups. The schizophrenia group only showed a difference between individual emotions in the static condition, where surprise was significantly better recognised than anger (p<0.01). Meanwhile, the control group recognised moving surprise significantly better than moving anger (p<0.001) and static surprise better than both static anger (p<0.01) and static sadness (p<0.05). This implies that there is featural information available in static surprise which increases recognition of this emotion and therefore improves the overall accuracy of responses for Emotion set 1 condition.

All three emotions (anger, sadness and surprise) were recognised significantly more accurately when viewed moving as opposed to static and this was the case for both groups. Comparisons between groups for individual emotions within the same Image Type showed no differences between the mean accuracy of the schizophrenia group and that of the control group. Therefore, in spite of there being a main effect overall for the control group being more accurate than the schizophrenia group the pattern of responses to individual emotions was equivalent across groups.

### 3.2.2. Analysis of emotion set 2

#### 3.2.2.1. Overall analysis by emotion, image type and group

A second 3 (Emotion; disgust, fear, happy) × 2 (Image Type; moving, static) × 2 (Group; schizophrenia, control) repeated measures ANOVA with Group as the only between-subjects factor was carried out on Emotion set 2. There was a significant main effect of Image Type (F(1, 38)=146.1, p<0.001), moving images were better recognised than static images. Again there was a significant main effect of Group (F(1, 38)=21.6, p<0.001) and a significant interaction between Image Type and Group, (F(1, 38)=18.3, p<0.001). Post hoc comparisons using Tukey’s HSD showed that in the moving condition the control group performed significantly more accurate overall than the schizophrenia group, but there was no difference between groups in the static condition. There was no main effect of Emotion (F(2, 76)=1.97, p>0.05) but Emotion interacted with Image Type (F(2, 76)=9.27, p<0.001). Post hoc analysis using Tukey’s HSD revealed that when viewed moving, fear was recognised significantly less accurately than both disgust (p<0.05) and happiness (p<0.001), regardless of group. However there were no differences between individual emotions in the static condition. There were no other significant interactions.

#### 3.2.2.2. Analysis of responses to individual emotions by image type and group

Analysis by Emotion within Group using Tukey’s HSD showed that the schizophrenia group performed with equivalent accuracy across all three emotions (disgust, fear and happiness) within each Image Type. The control group showed an advantage for recognising happiness more accurately than fear in the moving condition (p<0.05), but again there were no differences across individual emotions in the static condition.

Comparisons by Image Type showed that whereas the control group recognised all three emotions significantly more accurately from the moving than the static images (p<0.001 for each emotion), the schizophrenia group only showed this movement advantage for happiness (p<0.001). There was a trend towards a movement effect for disgust (p=0.087), but there was no difference between recognising fear from either moving or static images for the schizophrenia group. Indeed recognition of fear by this group was very low in both conditions (5.5 moving, 4.7 static, out of maximum of 12).

Furthermore, direct comparisons between Groups for each Emotion by Image Type showed that the control group performed significantly more accurately than the schizophrenia group in the moving condition at recognising happiness (p<0.01), disgust (p<0.05) and fear at a trend level (p=0.059), but there were no differences between groups for individual emotions when static.

### 4. Discussion

The aim of this study was to assess whether people with schizophrenia can recognise facial
emotions from moving images, as previous research has suggested that this process may be selectively impaired (Archer et al., 1994). The advantage of using the point-light imaging technique is that it creates images that display isolated biological movement patterns without cues from aspects of form (Johansson, 1973). Therefore, it was possible to directly investigate whether people with schizophrenia are aware of the biological motion patterns underlying expressions of emotion and consequently, whether they can use this information to accurately judge the actual emotions being expressed. The purpose of this was to ascertain whether the impairment reported by Archer et al. (1994) reflects a selective difficulty in the perception of emotional facial movement in schizophrenia.

The results of this study demonstrate both ability and disability on the schizophrenia group’s behalf. The schizophrenia group was able to accurately judge facial expressions of emotion from dynamic point-light images and at levels above those that would be expected by chance responding. Indeed, the schizophrenia group completed both the moving conditions significantly more accurately than their corresponding static condition. Further analysis regarding individual emotions showed that the schizophrenia group recognised all the emotions in Emotion set 1 (anger, sad and surprise) significantly more accurately from the moving images than the static images. In Emotion set 2, only happiness was recognised more accurately from the moving images than the static images, as there was only a trend towards this effect for disgust and there was no difference between the recognition of fear from moving and static images. In contrast, the control group demonstrated a significant movement advantage for each individual emotion.

In conclusion, this experiment finds no direct support for the notion that schizophrenia is associated with an emotion recognition deficit specific to moving images, as was previously demonstrated by Archer and colleagues (1994). In contrast, this study shows...
that people with schizophrenia can accurately perceive facial expressions of emotion from isolated motion patterns. Although they are less proficient than the control group, they present the same characteristics of performance as the control group. That is, the items which the control participants find hard to judge are also found more difficult by the schizophrenia group. Similarly, both groups find the same types of item to be more straightforward to interpret. Hence, it is proposed that the performance deficits presented by people with schizophrenia in this task, are more likely to support evidence for a global cognitive impairment associated with schizophrenia rather than an emotion, or movement, specific deficit.

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References


