Schizophrenia Research 127 (2011) 151–156

Contents lists available at ScienceDirect

Schizophrenia Research

journal homepage: www.elsevier.com/locate/schres

Attention shaping as a means to improve emotion perception deficits in outpatients with schizophrenia and impaired controls

Dennis R. Combs [a,*], Dustin Chapman [a], Jace Waguspack [a], Michael R. Basso [b], David L. Penn [c]

[a] University of Texas at Tyler, Department of Psychology, 3900 University Blvd., Tyler, TX 75799, United States
[b] University of Tulsa, Department of Psychology, 600 South College Ave. Tulsa, OK 74104, United States
[c] University of North Carolina at Chapel Hill, Department of Psychology, Chapel Hill, NC 27599, United States

ARTICLE INFO

Article history:
Received 2 March 2010
Received in revised form 30 April 2010
Accepted 5 May 2010
Available online 8 June 2010

Keywords:
Attention shaping
Emotion perception
Social cognition
Remediation
Outpatients
Impaired controls

ABSTRACT

Deficits in emotion perception are common in people with schizophrenia and current research has focused on improving these deficits. In our previous research, we demonstrated that directing attention to salient facial features via attention shaping can improve these deficits among inpatients. In this study, we examined the efficacy of an enhanced attention shaping program that contains 192 emotional expressions from which 25 are randomly presented for training. We extended our previous work by using repeated administrations of the shaping intervention and testing its effect in outpatients with schizophrenia and impaired controls. Fifteen participants with schizophrenia and fourteen college student controls with emotion perception deficits were randomly assigned to 1, 3 or 5 sessions of attention shaping. Participants completed 2 outcome measures of emotion perception, the FEIT and BLERT, not presented during the training, and underwent eye tracking at pre and post-tests. All conditions and groups improved, but the largest improvements on the BLERT and FEIT were found for persons assigned to the 5 session condition. Performance on the shaping program was positively correlated with the two outcome measures of emotion perception. There was less support for changes in visual scanning of faces as there was a relative reduction in total scanning time from pre-test to post-test. Results are interpreted in terms of the efficacy of attention shaping as a means to improve emotion perception deficits.

1. Introduction

Social cognition can be generally defined as the "mental operations underlying social interactions, which include the human ability and capacity to perceive the intentions and dispositions of others" (Brothers, 1990, p.28). Social cognition is a set of cognitive processes that are related and applied to the recognition, understanding, and processing of social information and interactions (Penn et al., 1997).

Social cognition has become an increasingly important area to target for intervention studies for a number of reasons. First, social cognition appears to be an independent construct that is distinct from neurocognition (van Hooren et al., 2008) and psychotic symptoms (Sergi et al., 2007b). Second, there is evidence for a "social cognitive neural circuit," which includes the amygdala, fusiform gyrus, superior temporal sulcus, and prefrontal cortices (Pinkham et al., 2003). Thirdly, and most importantly, social cognition has a robust association with social and community functioning (Couture et al., 2006). In fact, a large number of studies demonstrate that social cognition is a direct predictor (Bell et al., 2008; Bora et al., 2006; Brune, 2005; Pan et al., in press), mediator (Addington et al., 2006; Sergi et al., 2006; Vauth et al., 2004), or moderator (Nienow et al., 2006) of social and community functioning. In addition, some studies show that social cognition possesses a stronger relationship

* Corresponding author. Department of Psychology, Psychotic Disorders Research Laboratory, The University of Texas at Tyler, 3900 University Blvd., Tyler, Texas 75799, United States. Tel.: +1 903 565 5880; fax: +1 903 565 5660.
E-mail address: Dcombs@uttyler.edu (D.R. Combs).

0920-9964/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.schres.2010.05.011

with functional outcomes than does neurocognition (Penn et al., 1996; Pinkham and Penn, 2006; Roncone et al., 2002).

One of the most consistent social cognitive deficits in schizophrenia is the impaired recognition of emotional expressions in others (i.e., emotion perception; Edwards et al., 2002; Kohler et al., 2010; Mandal et al., 1998; Penn et al., 2006). Deficits in emotion perception appear to be stable, and occur across different phases of the disorder (Gaebel and Wölwer, 1992; Penn and Combs, 2000; Penn et al., 2000). They appear to contribute heavily to the social impairments found in schizophrenia (Hooker and Park, 2002; Ihnen et al., 1998; Kee et al., 2003; Mueser et al., 1996). In as much as emotion perception could be enhanced, social and community functioning may likewise improve.

Because antipsychotic medications yield little improvement to social cognition deficits in schizophrenia (Penn et al., 2009; Sergi et al., 2007a), non-medical interventions have recently been developed. These remediation interventions typically address one or more aspects of social cognition (emotion perception, theory of mind, etc.) and have demonstrated promising results (see reviews by Wölwer et al., 2010; Green et al., 2008; Horan et al., 2009). In two previous studies, we examined whether attention shaping methods could be used to improve emotion perception deficits in schizophrenia (Combs et al., 2006, 2008). The attention shaping intervention uses computerized attentional prompts to direct attention to the face and provides corrective feedback following each response (thus possibly shaping more appropriate face viewing strategies via feedback). We developed the attention shaping intervention based on research showing that: 1) poor attention corresponds with emotion perception deficits (Addington and Addington, 1998; Combs and Gouvier, 2004; Kee et al., 1998; Morrison et al., 1988), and 2) persons with schizophrenia show decreased scanning of salient facial areas (e.g., eyes, nose, and mouth) during emotion perception tasks (Gordon et al., 1992; Loughland et al., 2002; Phillips and David, 1997; Russell et al., 2008; Streit et al., 1997; Swartz et al., 1999; Williams et al., 2003). Presumably, if individuals with schizophrenia can be trained to focus attention to the facial features that manifest crucial cues regarding emotional expressions, then emotion perception might improve. Consistent with this assertion, our two previous studies show that attention shaping significantly improves emotion perception among inpatients with schizophrenia more so than interventions that used monetary reinforcement only or repeated practice (Combs et al., 2006, 2008; Penn and Combs, 2000). Despite these performance gains, shaping yielded only a trend for improved social functioning at 1 week follow-up.

The purpose of the current study was to examine an enhanced version of the attention shaping intervention. We felt that the intervention needed to be strengthened for several reasons. First, the original shaping intervention contained only 19 images from the Face Emotion Identification Test (FEIT; Kerr and Neale, 1993). Owing to this small number of stimuli, the FEIT's utility over repeated sessions as an intervention method is limited. Second, the FEIT includes faces of Caucacians only, thereby decreasing its utility in other ethnic groups (Pinkham et al., 2008). The shaping program now contains 192 images from the Montreal Facial Displays of Emotion series (MSFDE; Beaupré and Hess, 2005) that can be randomly selected for presentation, which allows for repeated training (consistent with cognitive remediation studies). In contrast to the FEIT, the MSFDE images are balanced by both gender (male and female) and ethnicity (African American, Asian, Hispanic, and Caucasian).

The present study extends our previous work in several other ways as well. In our previous studies, the shaping intervention was administered once and we wanted to determine if results improved with repeated administrations. Thus, participants in this study were randomly assigned to 1, 3, or 5 sessions. In addition, we included 2 unfamiliar measures of emotion perception that were not part of the shaping program to determine if the training generalized to other measures of emotion perception. We also wanted to explore the visual scanning parameters that might underlie emotion perception improvement following the shaping program (e.g., more time scanning salient facial features). Finally, we administered the intervention to outpatients with schizophrenia and a second group of college student control participants with emotion perception deficits (impaired controls) to determine if the program showed efficacy across different participant groups, thus strengthening the usefulness of the intervention. We expect the same pattern of findings with both groups.

In this study, we examined the efficacy of the attentional shaping intervention in 15 outpatients with schizophrenia and 14 college student controls with emotion perception deficits (impaired controls). Participants were randomly assigned to 1, 3 or 5 sessions and completed two unfamiliar measures of emotion perception at pre-test and post-test, the Face Emotion Identification Test (FEIT; Kerr and Neale, 1993) and the Bell–Lysaker Emotion Recognition Test (BLERT; Bell et al., 1997). We predicted that both groups would improve from pre-test to post-test, but the participants who completed the 5 session treatment would show the largest gains (Condition × Time interaction). In addition, we predicted that persons would spend more time viewing the eyes, nose, and mouth regions (within the Regions of Interest; ROI areas) following the shaping intervention. At present, there is little data on how the various social cognitive interventions affect visual scanning patterns for emotional expressions (see Russell et al., 2008).

2. Methods

2.1. Participants

Participants included 15 outpatients with schizophrenia and 14 impaired college student controls who showed scores less than 1 SD below the normative mean on the FEIT (FEIT $<$ 12; c.f. Penn et al., 2000). Table 1 presents demographic and clinical data for the groups. A diagnosis of schizophrenia or schizoaffective disorder was made by a trained researcher (DC) using the Structured Clinical Interview for DSM-IV (SCID-I/P; First et al., 2001). As expected, impaired controls were younger, $t\ (27) = 5.3$, $p < .001$, more educated, $t\ (27) = 3.8$, $p < .001$, and showed higher Social Functioning Scale total score (SFS; Birchwood et al., 1990), $t\ (27) = 3.0$, $p < .01$ than persons with schizophrenia. There were no differences in the gender ($X^2 = .02$, *ns*) or ethnic composition ($X^2 = 4.0$, *ns*) of the groups.

2.2. Measures

Participants completed two measures of emotion perception at pre and post-tests that were not part of the training. These measures included the Face Emotion Identification Test,

Table 1
Summary of participant characteristics.

Variable	Schizophrenia	Impaired control
	Mean (SD)	Mean (SD)
N	15	14
Age (years)	39.0 (10.9)	23.2 (4.0)
Educational level (years)	12.6 (1.4)	14.0 (1.5)
% White	60%	71%
% Male	60%	57%
% Schizophrenia	67%	–
CPZ Equivalents	759.6 (693.7)	–
% on Atypicals	73%	–
SFS total score	120.2 (24.5)	146.7 (21.7)*

CPZ = Chlorpromazine equivalents (see Woods, 2003); SFS = Social Functioning Scale.
*$p<.05$ (t test).

(FEIT; 19 items; scores range from 0 to 19) and The Bell–Lysaker Emotion Recognition Test (BLERT; 21 items; scores range from 0 to 21). The FEIT consists of black and white photographs while the BLERT contains audio and both were administered on videotape. Both of these measures have been widely used in schizophrenia research and showed acceptable levels of internal consistency for the samples (alpha .70+ for both groups).

2.3. Attention shaping intervention

The attention shaping intervention is a computerized training program that contains 192 images from the Montreal Set of Facial Displays of Emotions (MSFDE; Beaupré and Hess, 2005). The MSFDE contains 192 images balanced by gender and ethnicity across 6 different emotional expressions (happy, angry, sad, fear disgust, and shame) based on rater derived facial action coding units. From the set of 192 images, the attention shaping program randomly selects 25 expressions to present to the participant and each image appeared for 15 s (i.e., the entire face and head are shown). To direct attention to the face, a large blue cross appeared over the center of the each image (DirectRT software was used to program the time and location of the prompts). The cross appeared for 3 s (appeared at the same time as the face) and then faded from view. The three-second prompt time was selected based on research that problems in emotion perception occur early in the perceptual process (Gordon et al., 1992; Swartz et al., 1999; Turetsky et al., 2007). Participants responded using a response box (instead of a keyboard) and were told to press the labeled button that corresponded to the correct emotion. The words “correct” or “incorrect” appeared on the screen following their response to provide feedback.

2.4. Visual scanning methods

Eye movements were recorded with the eMagin Z800 3D Visor HMD unit with integrated View Point Eye Tracker software (Arrington Research). The HMD was linked to a Dell Precision 490 PC with an auxillary 22 in. monitor for observing the eye and online measures of pupil quality, gaze position, and calibration. The Dark Pupil tracking method was used with an infrared light and camera, making a monocular reading of the right eye at a temporal resolution of 30 Hz and a spatial resolution of 0.15°-visual arc. The potential confounds of head rotation and tilt were minimized by using the HMD apparatus. All participants underwent a 16 point calibration procedure prior to face scanning and a slip correction procedure was used between face presentations if a participant lost calibration during the task. Participants were shown 4 different emotional expressions (happy, angry, sad, and fear) and allowed to freely scan each face for 5 s. Following each face, a 2 s fixation dot was displayed, which directed gaze back to center. Regions of interest (ROIs) were constructed over the eyes, nose, and mouth due to their importance in emotional expressions (Loughland et al., 2002; Russell et al., 2008). The ROIs for the eyes were elliptical and centered approximately on the pupil (7° horizontal, terminating at the edge of the canthi, by 5° vertical, terminating at the eye brow ridge as the top of the ellipse). The mouth area ROI, also an ellipse, subtended 7° vertically, including the tip of the nose and the prominence of the chin, and 10° horizontally, terminating near the oral commissures. It was centered vertically half way between the lips and horizontally half way between the oral commissures, using the philtrum as a guide. These ROIs may appear larger by degree definition, but this is only because the face was stretched to fill the entire viewing screen, leaving no negative space.

2.5. Procedures

Participants with schizophrenia were recruited using flyers at local community mental health centers and in the newspaper. College students were recruited using an online research participation system. Participants were screened at the first session and those showing FEIT scores less than 12 were invited to participate in the full study (FEIT was administered only 1 time at screening and this served as the pre-test FEIT). All measures and procedures were administered by blinded graduate students in clinical psychology. Persons were randomly assigned using a random number table to 1, 3 or 5 sessions of attention shaping; eye tracking and the FEIT/BLERT were administered at pre and post-tests. Participants completed a training session on average every 2 days (3 sessions in 6 days; 5 sessions in 10 days) with the exception of 1 session participants who completed all procedures in the same day. Participants received $30 for the initial session and $20 for subsequent sessions. The study was approved by the appropriate institutional review board.

3. Results

There were no differences in pre-test FEIT, BLERT, or ROI total time scores for the groups (all $ts<2.0$, ns), but these conclusions are tempered by the modest sample size. The FEIT, BLERT, and ROI scores were normally distributed. For all analyses, we used a corrected p value of .01 for significance. There were no significant correlations between the FEIT/BLERT and age, educational level, gender, ethnicity, or SFS total score in the total sample (all $rs<.20$, ns) so these were not included as covariates in the main analyses. For persons with schizophrenia, there was no difference between persons with and without paranoid schizophrenia based on SCID diagnoses on the FEIT or BLERT (all $ts<2.0$, ns); medication type and dose were unrelated ($rs<.20$, ns) to emotion perception scores.

Within the shaping program itself, regardless of condition and group membership, there was a significant improvement in performance ($M = 17.1$ vs. $M = 19.7$, $t(27) = 3.8$, $p < .001$; out of 25 possible images selected) suggesting that persons generally improved over time during the training. More importantly, the number of emotions correctly identified in the shaping program (out of 25 possible) at session 3 and session 5 (end point of training) was positively correlated with the emotion perception outcome scores in the total sample (r values .64–.79; $p < .01$). There was a trend for a negative correlation between shaping performance at session 5 and visual scanning total time within the ROI in the total sample ($r = -.60$, $p < .07$), and the correlation at session 3 was in the same direction, but not significant ($r = -.13$, ns). Thus, persons who completed 5 sessions of training showed a tendency to scan the ROI areas less. It should be emphasized that the images in the shaping program and the BLERT/FEIT and eye tracking task were different.

Changes over time in BLERT scores were examined using a 2 (Group: schizophrenia vs. impaired controls) × 3 (Condition: 1, 3, 5 sessions) × 2 (within subjects for Time: pre-test vs. post-test) mixed model ANOVA. There was a significant main effect for Group, $F(1, 23) = 26.0$, $p < .0001$, $\eta_p^2 = .53$, as BLERT scores were higher in the impaired control group than persons with schizophrenia ($p < .001$) and a significant Time effect, $F(1, 23) = 28.5$, $p < .001$, $\eta_p^2 = .55$ as all groups improved over time ($p < .001$). However, there was a significant Condition × Time interaction, $F(1, 23) = 5.6$, $p < .01$, $\eta_p^2 = .32$. Probing of the interaction effect showed that persons in the 5 session condition, regardless of group membership, significantly improved from pre-test to post-test on the BLERT ($p < .001$) as compared to persons in the 1 and 3 session conditions.

Changes over time in FEIT scores was examined using a 2 (Group: schizophrenia vs. impaired controls) × 3 (Condition: 1, 3, or 5 sessions) × 2 (within subjects for Time: pre-test vs. post-test) mixed model ANOVA. There was a non-significant main effect for group, $F(1, 23) = .71$, ns, $\eta_p^2 = .01$ as both groups were similar on the FEIT at pre-test and improved to the relatively the same level at the end of treatment. There was however, a significant effect for Time, $F(1, 23) = 17.5$, $p < .001$, $\eta_p^2 = .43$, but this was tempered by a significant Condition × Time interaction, $F(1, 23) = 3.9$, $p < .03$, $\eta_p^2 = .25$. Similar to the BLERT, persons in the 5 session condition showed significant improvements from pre-test to post-test on the FEIT ($p < .005$), as compared those in the 1 and 3 session conditions. Overall, all conditions improved, but the largest improvements were in the 5 session condition.

To examine differences in mean total scanning time within the ROI areas (ROI Total Time) we conducted a 2 (Group: schizophrenia vs. impaired controls) × 3 (Condition: 1, 3, or 5 sessions) × 2 (within subjects for Time: pre-test vs. post-test) mixed model ANOVA. There was a significant Group × Condition interaction effect, $F(2, 23) = 4.8$, $p < .05$, $\eta_p^2 = .31$. The significant Group × Condition interaction resulted from more variable ROI scan times for persons with schizophrenia in the 5 session condition as compared to the 1 and 3 session conditions ($p < .01$). Perhaps more interesting is that visual scanning time within the ROI areas (see ROI Diff and % time spent in ROI) decreased from pre to post-test for persons in the 3 and 5 session conditions, but increased in persons in the 1 session condition—a pattern evident in both groups (see Table 2). This implies that scanning within the ROI's increased in the 1 session group, but actually decreased in the participants who received 3 or 5 sessions.

4. Discussion

In this study, we examined the efficacy of an enhanced attention shaping program in a sample of outpatients with schizophrenia and a group of impaired college student controls. We extended our previous research by randomly assigning participants to 1, 3, or 5 sessions of training. Outcome measures included two emotion perception tasks that were not part of the intervention, which reduced the potential impact of practice effects. We also explored the effect of the shaping program on visual scanning patterns, which may underlie improvements.

Overall, we are encouraged by the results and it appears that the shaping intervention is quite robust for the different participant groups. The effect sizes were largest in the 5 session

Table 2
Emotion perception and visual scanning scores by group and condition.

Condition						
Variable	1 Session		3 Sessions		5 Sessions	
	Pre	Post	Pre	Post	Pre	Post
Schizophrenia						
N	6		4		5	
BLERT	12.6 (2.8)	14.0 (2.5)	12.5 (4.3)	13.0 (4.2)	9.0 (3.8)	15.4 (2.0)*
FEIT	10.6 (1.2)	11.3 (1.8)	11.7 (1.2)	12.7 (2.2)	9.4 (2.8)	14.4 (1.9)*
ROI Time (*ms*)	6236.6 (3889)	9841.4 (6114)	8904.7 (2192)	5222.9 (2254)	12876.4 (1758)	12344.8 (872)
ROI Diff	+3604.6 (9054.0)		−3681.8 (4350.7)		−417.6 (1227.3)	
% Time in ROI	31.0 (19.3)	48.9 (3.4)	44.3 (10.9)	25.9 (11.2)	64.0 (8.7)	61.4 (4.3)
Impaired controls						
N	4		5		5	
BLERT	16.8 (2.1)	17.6 (1.1)	16.2 (3.2)	18.6 (1.3)	16.2 (2.2)	19.2 (2.2)*
FEIT	11.0 (0.7)	11.6 (3.3)	10.4 (1.3)	13.0 (1.6)	10.7 (1.2)	14.5 (0.5)*
ROI Time (*ms*)	9663.7 (1900)	9730.2 (1931)	8903.5 (2850)	7623.6 (2981)	8596.5 (2850)	8113.4 (4932)
ROI Diff	+66.5 (2628.6)		−1279.4 (5739)		−620.3 (3801.7)	
% Time in ROI	48.1 (9.6)	48.3 (9.6)	44.2 (18.1)	37.9 (14.8)	42.7 (14.1)	40.3 (24.5)

Note. ROI = Region of Interest; ROI Diff = Post Test Time minus Pre-Test Time in region of interest; BLERT = Bell–Lysaker Emotion Recognition Test; FEIT = Face Emotion Identification Test; % Time in ROI = (ROI time within/total time) × 100; * = significant change from pre to post test for group (Condition × Time interaction effect).

condition. The shaping intervention has now shown efficacy in inpatient, outpatient and non-clinical samples, although the conclusions of the present study should be tempered due to modest sample sizes. Also, those who received 5 sessions of the training improved the most, suggesting that gains can be improved with more intensive training. In addition, performance on the shaping program at end point was positively correlated with scores on the outcome measures of emotion perception. Notably, our participants achieved post-treatment scores on the BLERT and FEIT that were on par with nonpsychiatric controls, thereby reflecting the clinical significance of the improvements (see Penn et al., 2000; Penn and Combs, 2000).

In terms of visual scanning patterns, our results showed non-significant changes from pre to post-tests following completion of the attention shaping program. These results are consistent with Russell et al. (2008) who found inconsistent changes in visual scanning parameters following a 1 session remediation with the Ekman Micro-Expression Training Tool (METT). However, persons in the 3 and 5 session conditions, regardless of group membership, showed a relative decrease in total scan time (and % time) within the ROI areas while persons in the 1 session condition showed an increase in ROI scan time (see Russell et al., 2008). However, scan times within the schizophrenia group were highly variable compared to impaired controls. In light of research that persons with schizophrenia tend to show a reduction in scanning facial features, our results might be due to several possibilities. First, it is possible that the shaping program does not directly alter or affect gaze patterns and the improvements on the FEIT and BLERT are due to some other factor such as the preconscious or very early perceptual encoding of the face (between 17 ms and 170 ms; Mogg and Bradley, 1999; Turetsky et al., 2007). It is possible that the effects are simply due to repeated practice, but in our two previous studies, repeated practice did not improve emotion perception (Combs et al., 2006, 2008). It has been argued that emotion perception is more of a gestalt process (whole face) instead of a controlled data driven strategy in which the person scans facial features (Joshua and Rossell, 2009), which may lead to decreased scanning times. Second, it is possible that following training, the persons are more efficient (efficiency consists of accuracy and speed components) at scanning faces as the shaping program taught them a compensatory strategy for extracting the most crucial data. This is partially supported by decreased scan times and % time spent viewing the ROIs in conjunction with improved emotion perception on the BLERT and FEIT at post-test, but we did not collect data on reaction time during eye tracking to see if decisions were made more quickly after training.

Limitations of the study include a modest sample size, which might have reduced our ability to detect significant differences (in addition to our more conservative *p* value used for significance) or relationships among some of the study variables, the lack of assessment of symptoms or cognitive functioning, and the lack of a follow-up measurement period. We did not include symptoms/cognitive measures given the time demands of the study. In our previous study using inpatients, neither symptoms nor cognition were not related to improvement (Combs et al., 2008), but others have found a link to negative symptoms and visual scanning behaviors (Green et al., 2003; Loughland et al., 2002). Also, it is possible that placing prompts over each salient feature, such as the eyes, nose, and mouth areas instead of the center of the face or integrating eye tracking into the shaping program to see if improvement is gradual or immediate might lead to stronger gains. Finally, we did not report data for individual emotions and instead focused on total scores as data for individual emotions is often less reliable due to few items.

The role of attention shaping in the improvement of emotion perception remains to be seen. The procedures described in this study are now being incorporated into existing treatments, such as Social Cognition and Interaction Training (Combs et al., 2007). The portability and brevity of the intervention may make it an attractive alternative to longer and more costly interventions such as cognitive remediation. Also, the intervention is grounded in research and theory on the role of attention to the face and represents a form of “translational research” between the laboratory and community. We are currently examining the attention shaping intervention in schizotypal and first episode clients. Future studies will compare attention shaping with other social cognitive interventions to provide a direct comparison of efficacy. We also have little data on what are the ideal visual scanning parameters and in this study we used impaired controls. We will continue to look at ways to improve the intervention and hope that these methods can be of value to others who to look to improve social cognition in schizophrenia.

Role of the funding source

Support for the development of the attention shaping program was provided by a grant from the National Institutes of Mental Health (NIMH Grant #1 R03 MH07651-01A1) to Dennis R. Combs. The NIMH had no further role in the study design; in the collection, analysis, or interpretation of the data; in the writing of the manuscript; and in the decision to submit the paper for publication.

Contributors

Dennis R. Combs served as the principal investigator (PI) for the study. David L. Penn and Michael R. Basso assisted with the study design, statistical analyses, and preparation of the manuscript. Dustin Chapman and Jace Waguspack assisted with the study design, participant recruitment and tracking, and administration of the research protocol.

Conflict of interest

None to report.

Acknowledgements

We would like to thank The University of Texas at Tyler and the Andrews Center for their support on this study.

References

Addington, J., Addington, D., 1998. Facial affect recognition and information processing in schizophrenia and bipolar disorder. Schizophr. Res. 32, 171–181.
Addington, J., Saeedi, H., Addington, D., 2006. Facial affect recognition: a mediator between cognitive and social functioning in psychosis. Schizophr. Res. 85, 142–150.
Beaupré, M., Hess, U., 2005. Cross-cultural emotion recognition among Canadian ethnic groups. J. Cross-Cult. Psychol. 36, 355–370.
Bell, M., Bryson, G., Lysaker, P., 1997. Positive and negative affect recognition in schizophrenia: a comparison with substance abuse and normal control subjects. Psychiatry Res. 73, 73–82.
Bell, M., Tsang, H.W., Greig, T.C., Bryson, G.J., 2008. Neurocognition, social cognition, perceived social discomfort, and vocational outcomes in schizophrenia. Schizophr. Bull. S0586–S7614.
Birchwood, M., Smith, J., Cochrane, R., Wetton, S., Copestake, S., 1990. The Social Functioning Scale: the development and validation of a new scale of social adjustment for use in family intervention programmes with schizophrenic patients. Br. J. Psychiatry 157, 853–859.
Bora, E., Eryavuz, A., Kayahan, B., Sungu, G., Veznedaroglu, B., 2006. Social functioning, theory of mind and neurocognition in outpatients with

schizophrenia; mental state decoding may be a better predictor of social functioning than mental state reasoning. Psychiatry Res. 145, 95–103.
Brothers, L., 1990. The social brain: a project for integrating primate behavior and neurophysiology in a new domain. Concepts Neurosci. 1, 27–61.
Brune, M., 2005. Emotion recognition, theory of mind, and social behavior in schizophrenia. Psychiatry Res. 133, 135–147.
Combs, D.R., Adams, S.D., Penn, D.L., Roberts, D.L., Tiegreen, J.A., Stem, P., 2007. Social cognition and interaction training for schizophrenia spectrum disorders: preliminary findings. Schizophr. Res. 91, 112–116.
Combs, D.R., Gouvier, W.D., 2004. The role of attention in affect perception: an examination of Mirsky's four factor model of attention in chronic schizophrenia. Schizophr. Bull. 3, 727–738.
Combs, D.R., Tosheva, A., Penn, D.L., Basso, M.R., Wanner, J.L., Laib, K., 2008. Attentional-shaping as a means to improve emotion perception deficits in schizophrenia. Schizophr. Res. 105, 68–77.
Combs, D.R., Tosheva, A., Wanner, J., Basso, M.R., 2006. Remediation of emotion perception deficits in schizophrenia: the use of attentional prompts. Schizophr. Res. 87, 340–341.
Couture, S., Roberts, D., Penn, D.L., 2006. The functional significance of social cognition in schizophrenia. Schizophr. Bull. 32, S44–S63.
Edwards, J., Jackson, H., Pattison, P.E., 2002. Emotion recognition via facial expression and affective prosody in schizophrenia: a methodological review. Clin. Psychol. Rev. 22, 789–832.
First, M.B., Spitzer, R.L., Gibbon, M., Williams, J.B.W., 2001. Structured Clinical Interview for DSM-IV Axis I Disorders, Patient Edition. Biometrics Research Department, New York.
Gaebel, W., Wölwer, W., 1992. Facial expression and emotional face recognition in schizophrenia and depression. Eur. Arch. Psychiatry Clin. Neurosci. 242, 46–52.
Gordon, E., Coyle, S., Anderson, J., Healy, P., Cordaro, J., Latimer, C., Mears, R., 1992. Eye movement response to a facial stimulus in schizophrenia. Biol. Psychiatry 31, 626–629.
Green, M.F., Penn, D.L., Bentall, R.P., Carpenter, W.T., Gaebel, W., Gur, R.C., Kring, A.M., Park, S., Silverstein, S.M., Heinssen, R., 2008. Social cognition in schizophrenia: an NIMH workshop on definitions, assessment, and research opportunities. Schizophr. Bull. 34 (6), 1211–1220.
Green, M., Williams, L.M., Davidson, D., 2003. Visual scanpaths to threat-related faces in deluded schizophrenia. Psychiatry Res. 119, 271–285.
Hooker, C., Park, S., 2002. Emotion processing and its relationship to social functioning in schizophrenia patients. Psychiatry Res. 112, 41–50.
Horan, W.P., Kern, R.S., Green, M.F., Penn, D.L., 2009. Social cognition training for individuals with schizophrenia: emerging evidence. American Journal of Psychiatric Rehabilitation 11 (3), 205–252.
Ihnen, G.H., Penn, D.L., Corrigan, P.W., Martin, J., 1998. Social perception and social skill in schizophrenia. Psychiatry Res. 80, 275–286.
Joshua, N., Rossell, S., 2009. Configural face processing in schizophrenia. Schizophr. Res. 112, 99–103.
Kee, K.S., Green, M.F., Mintz, J., Brekke, J.S., 2003. Is emotion processing a predictor of functional outcome in schizophrenia? Schizophr. Bull. 29, 487–497.
Kee, K.S., Kern, R.S., Green, M.F., 1998. Perception of emotion and neurocognitive functioning in schizophrenia: what's the link? Psychiatry Res. 81, 57–65.
Kerr, S.L., Neale, J.M., 1993. Emotion perception in schizophrenia: specific deficit or further evidence of generalized poor performance? J. Abnorm. Psychol. 102, 312–318.
Kohler, C.G., Walker, J.B., Martin, E.A., Healy, K.M., Moburg, P.J., 2010. Facial Emotion Perception in Schizophrenia: A meta-analytic Review. Schizophr. Bull. 36 (5), 1009–1019.
Loughland, C.M., Williams, L.M., Gordon, E., 2002. Visual scan paths to positive and negative facial emotions in an outpatient schizophrenia sample. Schizophr. Res. 55, 159–170.
Mandal, M.K., Pandey, R., Prasad, A.B., 1998. Facial expressions of emotions and schizophrenia: a review. Schizophr. Bull. 24, 399–412.
Mogg, K., Bradley, B.P., 1999. Orienting of attention to threatening facial expressions presented under conditions of restricted awareness. Cogn. Emotion 13, 713–740.
Morrison, R.L., Bellack, A.S., Bashore, T.R., 1988. Perception of emotion among schizophrenic patients. J. Psychopathol. Behav. Assess. 10, 319–332.
Mueser, K.T., Doonan, R., Penn, D.L., Blanchard, J.J., Bellack, A.S., Nishith, P., et al., 1996. Emotion recognition and social competence in chronic schizophrenia. J. Abnorm. Psychol. 105, 271–275.
Nienow, T.M., Docherty, N.M., Cohen, A.S., Dinzeo, T.J., 2006. Attentional dysfunction, social perception, and social competence. J. Abnorm. Psychol. 115, 408–417.
Pan, Y., Sue-Huei, C., Wei, J.C., Shi-Kai, L., in press. Affect recognition as an independent social function determinant in schizophrenia. Comprehensive Psychiatry.
Penn, D.L., Addington, J., Pinkham, A., 2006. Social cognitive impairments. In: Lieberman, J.A., Stroup, T.S., Perkins, D.O. (Eds.), American Psychiatric Association Textbook of Schizophrenia. American Psychiatric Publishing Press, Inc., Arlington, VA, pp. 261–274.
Penn, D.L., Combs, D.R., 2000. Modification of affect perception deficits in schizophrenia. Schizophr. Res. 46, 217–229.
Penn, D.L., Combs, D.R., Ritchie, M., Francis, J., Cassissi, J., Morris, S., 2000. Emotion recognition in schizophrenia: further investigation of generalized versus specific deficit models. J. Abnorm. Psychol. 109, 512–516.
Penn, D.L., Corrigan, P.W., Bentall, R.P., Racenstein, J.M., Newman, L., 1997. Social cognition in schizophrenia. Psychol. Bull. 121, 114–132.
Penn, D.L., Keefe, R., Davis, D., Meyer, P., Perkins, D., Losardo, D., Lieberman, J., 2009. The effects of antipsychotic medications on emotion perception in patients with chronic schizophrenia in the CATIE trial. Schizophr. Res. 115, 17–23.
Penn, D.L., Spaulding, W., Reed, D., Sullivan, M., 1996. The relationship of social cognition to ward behavior in chronic schizophrenia. Schizophr. Res. 20, 327–335.
Phillips, M.L., David, A.S., 1997. Visual scan paths are abnormal in deluded schizophrenics. Neuropsychologia 35, 99–105.
Pinkham, A.E., Penn, D.L., 2006. Neurocognitive and social cognitive predictors of social skill in schizophrenia. Psychiatry Res. 143, 167–178.
Pinkham, A.E., Penn, D.L., Perkins, D.O., Lieberman, J., 2003. Implications for the neural basis of social cognition for the study of schizophrenia. Am. J. Psychiatry 160, 815–824.
Pinkham, A.E., Sasson, N.J., Calkins, M.E., Richard, J., Hughett, P., Gur, R.E., Gur, R.C., 2008. The other-race effect in face processing among African Americans and Caucasian individuals with schizophrenia. Am. J. Psychiatry 165, 639–645.
Roncone, R., Falloon, I.R.H., Mazza, M., 2002. Is theory of mind in schizophrenia more strongly associated with clinical and social functioning than with neurocognitive deficits? Psychopathology 35, 280–288.
Russell, T.A., Green, M.J., Simpson, I., Coltheart, M., 2008. Remediation of facial emotion perception in schizophrenia: concomitant changes in visual attention. Schizophr. Res. 103, 248–256.
Sergi, M.J., Green, M.F., Widmark, C., Reist, C., Erhart, S., Braff, D., Kee, K., Marder, S., Mintz, J., 2007a. Social cognition and neurocognition: effects of risperidone, olazapine, and haloperidol. Am. J. Psychiatry 164, 1585–1592.
Sergi, M.J., Rassovsky, Y., Nuechterlein, K.H., Green, M.F., 2006. Social perception as a mediator of influence of early visual processing on functional status in schizophrenia. Am. J. Psychiatry 163, 448–454.
Sergi, M.J., Rassovsky, Y., Widmark, C., Reist, C., Erhart, S., Braff, D.L., Marder, S.R., Green, M.F., 2007b. Social cognition in schizophrenia: relationships with neurocognition and negative symptoms. Schizophr. Res. 90, 316–324.
Streit, M., Wölwer, W., Gaebel, W., 1997. Facial-affect recognition and visual scanning behaviour in the course of schizophrenia. Schizophr. Res. 24, 311–317.
Swartz, B.L., Rosse, R.B., Johri, S., Deutsch, S.I., 1999. Visual scanning of facial expressions in schizophrenia. J. Neuropsychiatry Clin. Neurosci. 11, 103–106.
Turetsky, B.I., Kohler, C.G., Indersmitten, T., Batí, M.T., Charbonnier, D., Gur, R.C., 2007. Emotion recognition in schizophrenia: when and why does it go awry? Schizophr. Res. 94, 253–263.
van Hooren, S., Versmissen, D., Janssen, I., Myin-Germeys, I., Campo, J., Mengelers, R., van Os, J., Krabbendam, L., 2008. Social cognition and neurocognition as independent domains in psychosis. Schizophr. Res. 103, 257–265.
Vauth, R., Rusch, N., Wirtz, M., Corrigan, P.W., 2004. Does social cognition influence the relation between neurocognitive deficits and vocational functioning in schizophrenia? Psychiatry Res. 128, 155–165.
Williams, L.M., Loughland, C.M., Green, M.J., Harris, A.W.F., Gordon, E., 2003. Emotion perception in schizophrenia: an eye movement study comparing the effectiveness of risperidone vs. haloperidol. Psychiatry Res. 120, 13–27.
Wölwer, W., Combs, D.R., Frommann, N., Penn, D.L., 2010. Treatment approaches with a special focus on social cognition: overview and empirical results. In: Medalia, A. Roder, V. (Eds.), Neurocognition and Social Cognition in Schizophrenia Patients: Basic Concepts and Treatment. (pp. 61–78), Karger Publishers, Basel, Switzerland.
Woods, S.W., 2003. Chlorpromazine equivalent doses for the newer atypical antipsychotics. J. Clin. Psychiatry 64, 663–667.