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## A Meta-Analysis of Emotion Perception and Functional Outcomes in Schizophrenia

Farzin Irani, Ph.D.<sup>1</sup>, Sarah Seligman, B.A.<sup>1</sup>, Vidyulata Kamath, Ph.D.<sup>1</sup>, Christian Kohler, M.D.<sup>1</sup>, and Ruben C. Gur, Ph.D.<sup>1,2</sup>

<sup>1</sup>Neuropsychiatry Section, Department of Psychiatry, University of Pennsylvania School of Medicine, Philadelphia, PA

<sup>2</sup>Philadelphia Veterans Affairs Medical Center, Philadelphia, PA

### Abstract

**Introduction**—Emotion perception (EP) is impaired in schizophrenia, is stable across clinical state, resistant to antipsychotic treatment and linked to symptom severity. Given its pervasive nature, there is a need to quantitatively examine whether this dysfunction impacts functional outcomes. We used a meta-analytic strategy to combine results from several studies and examine synthesized effect sizes.

**Methods**—A Meta-analysis Of Observational Studies in Epidemiology standard was used to extract data following a PubMed and PsychInfo search. Studies reporting correlations between measures of EP and functional outcomes in schizophrenia spectrum disorders were selected. The impact of potential methodological (task type), demographic (sex, age, race, education, marital status) and clinical (age of onset, duration of illness, setting, symptoms, anti-psychotic medication) moderators on effect sizes were examined.

**Results**—Twenty-five studies met inclusion criteria and included 1306 patients who were 37 years old, with 12 years of education, 64% male and 63% Caucasian. There was a significant relationship between EP and functional outcomes in individuals with schizophrenia or schizoaffective disorder, with effect sizes in the medium range. Medium to large range positive correlations were observed between emotion identification and functional outcome domains involving social problem solving, social skills and community functioning. Significant moderators included task type (emotion identification tasks), sex (% male in sample), race (% Caucasian in sample) and clinical symptoms (negative and positive).

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Address correspondence to Farzin Irani, Ph.D., Neuropsychiatry Section, Department of Psychiatry, 10<sup>th</sup> Floor, Gates Building, University of Pennsylvania School of Medicine, 3400 Spruce Street, Philadelphia, PA 19104. Tel. (215) 662-7389. Fax. (215) 662-7903. firani@upenn.edu.

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### Conflict of Interest

None

### Contributors

All authors have significantly contributed to the final manuscript. The manuscript in its final form has been approved by all authors.

Author F. Irani has contributed to the conceptualization, data analysis and writing of the manuscript.

Author R. Gur has contributed to the writing of the manuscript.

Author V. Kamath has contributed to the conceptualization, data analysis and writing of the manuscript.

Author C. Kohler has contributed to the writing of the manuscript.

Author S. Seligman has contributed to the data entry, data analysis and writing of the manuscript.

**Conclusions**—Emotion identification deficits are associated with functional impairments in schizophrenia and moderated by sex, race and symptoms. This has implications for treatment efforts to improve outcomes.

### Keywords

emotion perception; social cognition; schizophrenia; functional outcome; quality of life; meta-analysis

## 1. Introduction

Social cognition deficits are consistently observed in schizophrenia and include impairments in emotion perception, theory of mind, social perception, social knowledge and attributional bias (Michael F Green, Olivier, Crawley, Penn, & Silverstein, 2005; M. F. Green et al., 2008). Of the social cognition domains, the one that has been identified and studied the most frequently in schizophrenia is emotion perception (EP). EP refers to the ability to infer emotional information from facial expressions, vocal inflections or some combination of these (Couture, Penn, & Roberts, 2006). The interpretation and expression of affect is fundamental to the human experience (Darwin, 1965). While patients with schizophrenia report experiencing as much positive and negative emotion as healthy comparison groups (Kring, Kerr, Smith, & Neale, 1993), deficits in EP are an intrinsic and stable aspect of the pathophysiology of schizophrenia (Edwards, Jackson, & Pattison, 2002; Irani et al., in press; C. G. Kohler & Martin, 2006; Mandal, Pandey, & Prasad, 1998; Morrison, Bellack, & Mueser, 1988; Phillips & Seidman, 2008). A recent meta-analytic review of 77 studies of EP in schizophrenia demonstrated large effect size deficits ( $d=-0.91$ ) moderated by task, illness-related and demographic factors (C.G. Kohler, Walker, Martin, Healey, & Moberg, 2010). Other work has shown that EP deficits are linked to vulnerability for schizophrenia (Phillips & Seidman, 2008) and negative symptoms such as flat affect (Gur et al., 2006), which are resistant to treatment with anti-psychotics (Harvey, Patterson, Potter, Zhong, & Brecher, 2006; David L. Penn et al., 2009; Sergi et al., 2007). This has led to burgeoning efforts to improve EP abilities through targeted, efficacious emotion remediation programs (Combs, Chapman, Waguspack, Basso, & Penn, in press; Combs et al., 2008; Combs, Tosheva, Wanner, & Basso, 2006; Frommann, Streit, & Wölwer, 2003; Horan et al., 2009; D. L. Penn & Combs, 2000; T.A. Russell, Chu, & Phillips, 2006; T. A. Russell, Green, Simpson, & Coltheart, 2008; Silver, Goodman, Knoll, & Isakov, 2004; Wolwer et al., 2005).

Improvements in EP abilities may impact functional outcomes in schizophrenia. A recent qualitative review of the literature suggested that there may be a significant association between EP impairments and poor functional outcomes in community functioning, social behavior in the milieu and social skills (Couture et al., 2006). Yet, the lack of a quantitative analysis of the data precluded generalizability of conclusions reached. A meta-analytic approach permits combining results from several studies to examine synthesized effect sizes, which offer more powerful estimates of true population effects than those derived from a single study. Such a meta-analytic strategy was recently used to more broadly examine the relationship between functional outcomes and cognitive performance in schizophrenia (Fett et al., in press). Both neurocognition and social cognition were associated with outcomes, with effect sizes spanning the small to large range. While a broad analytic approach highlighted that social cognition domains were more strongly associated with community functioning than neurocognition, there are methodological limitations associated with conducting multiple comparisons on heterogeneous tasks that tap several neurocognitive and social cognitive domains in a single analysis. The scope of the analysis also precluded

careful examination of important demographic and clinical moderators and a functional subdomain analysis.

Thus, here we specifically targeted the relationship between EP and functional outcomes in schizophrenia. Since functional outcome is a multifaceted construct that has been measured in diverse ways, we relied on previous classifications of functional outcome domains: social behavior in the milieu, social skills, social problem solving and community functioning (Couture et al., 2006). Social behavior in the milieu consists of staff-rated assessments of behavior in a variety of treatment settings, while social skills evaluates role-plays and rates specific interactional skills such as eye contact. Social problem solving is conceptualized as the ability to generate solutions to everyday social problems, while community functioning broadly encompasses behaviors and activities related to independent living skills, such as social or work functioning. We also more closely examined subdomains of these functional domains and moderators such as age, sex, race, education, marital status, antipsychotic medication use, age of illness onset, duration of illness, symptoms, setting and task type. Overall, we aimed to 1) clarify the strength of the effect between emotion perception and functional outcomes and 2) identify demographic and clinical variables that moderated the strength of the effects.

## 2. Methods

### 2.1 Literature Search Strategy and 2.2 Data Extraction

See online supplemental material.

### 2.3 Emotion Perception Tasks

There were two types of tasks used to assess EP abilities: emotion identification and emotion differentiation. Emotion identification involves ascribing a qualitative label (e.g., happy, angry, sad) to emotional facial or vocal expressions based on a set of choices. Emotion differentiation encompasses tasks assessing the ability to identify differences between intensities of emotional expressions.

### 2.4 Functional Outcome Domains and Subdomains

As described, domains of functional outcome were categorized using four previously established domains: community functioning, social behavior in the milieu, social problem solving, and social skills (Couture et al., 2006). We also used subdomains reflected in the functional outcome scales to more closely inspect the components most closely associated with emotion processing. These were appropriate affect, communication dysfunction, global outcome, inappropriate behavior, independent living skills, interpersonal anguish, nonverbal social skills, verbal social skills, occupational dysfunction, overall social skills, performance-based skills, relationships, self-care, social adjustment, social functioning and work productivity. Among those that were less obvious, “medication management” was included in community functioning/global outcome (Fiszdon & Johannesen, 2010) and “disturbing and aggressive behaviors” was grouped with social behavior in the milieu/relationships (Pan, Chen, Chen, & Liu, 2009). “Altered activity level” (Mueser et al., 1996) and “intrapsychic foundations” (Poole, Tobias, & Vinogradov, 2000) were removed from subanalysis as these were not deemed relevant to the subgroups.

### 2.5 Moderator Variables

Several moderators were coded in the current meta-analysis, including *patient diagnosis* (schizophrenia, mixed sample including schizoaffective, mixed sample including psychotic disorder NOS), *age*, *years of education*, *sex* (% male), *race* (% Caucasian), *marital status* (% married), *antipsychotic medication status*, *age of illness onset*, *duration of illness (months)*,

*setting (inpatient, outpatient, mixed) and positive and negative symptoms.* Studies including mean number of schizophrenia symptoms used either the Scales for the Assessment of Positive Symptoms (SAPS; Andreasen, 1984b) and Negative Symptoms (SANS; Andreasen, 1984a) or the Positive and Negative Symptom Scale (PANSS-P & PANSS-N; Kay, Fiszbein, & Opler, 1987). We also examined impact of whether a task was presented in *visual or auditory* modality.

## 2.6 Statistical Analysis

See online supplemental material

## 3. Results

### 3.1 Publication Bias

Results of the Begg and Mazumdar (1994) rank correlation test ( $p = .27$ , one-tailed) and Egger et al. (1997) test ( $p = .17$ , one-tailed) indicated no evidence of publication bias. In addition, the *fail-safe N* indicated that 172 'null' studies would have to be located and included in order to nullify the observed effect.

### 3.2 Overall Meta-analysis Results

Table 1 presents the 25 source articles used in the analysis and the 82 cases extracted from these articles that provided functional outcome domains/subdomains correlated with EP measures. As indicated in the summary row on this Table, the sample included 1306 patients who were 37 years old, with 12 years of education, 64% male, 63% Caucasian and 28% who were ever married. Additional moderators are also included in Table 1. Overall analysis of the relationship between EP and functional outcomes revealed an effect size of 0.31 (95% CI  $0.13 < \delta < 0.49$ ,  $p = 0.001$ ). An analysis of homogeneity across all studies revealed significant variance among study effect sizes ( $Q_B[29] = 63.80$ ,  $p < 0.001$ ,  $I_2 = 54.55$ ). This indicated that these effects sizes differed more than would be expected from sampling error alone, perhaps due to differences associated with study (or sample) characteristics. Therefore, to further understand the variability among effect sizes, methodological, clinical and demographic variables that might explain this heterogeneity were examined further.

### 3.3 Emotion Perception Task Type

Tasks assessing emotion differentiation were not significantly associated with functional outcomes ( $N = 6$ ,  $\delta = 0.16$ , 95% CI  $-0.10 < \delta < 0.42$ ,  $p = 0.24$ ), but this analysis may have been underpowered. On the other hand, the association between emotion identification and functional outcomes was statistically significant ( $N = 24$ ,  $\delta = 0.36$ , 95% CI  $0.14 < \delta < 0.57$ ,  $p = 0.001$ ). Therefore, only those cases using emotion identification tasks were included in subsequent analyses. The effect size for emotion identification tasks was also heterogeneous ( $Q_B[23] = 58.42$ ,  $p < 0.001$ ,  $I_2 = 60.63$ ) further requiring focus on this task in subsequent analyses.

### 3.4 Emotion Identification and Functional Outcome Domains and Subdomains

Figure 1 shows that when examining the relationship between EP as measured by emotion identification tasks and functional outcome domains, community functioning ( $Z = 2.17$ ,  $p = 0.03$ ), social problem solving ( $Z = 3.17$ ,  $p = 0.002$ ) and observed social skills ( $Z = 3.69$ ,  $p < 0.001$ ) were positively associated with emotion identification abilities while social behavior in the milieu was not ( $Z = -0.18$ ,  $p = 0.86$ ). Further examination of the subdomains that comprise the functional domains revealed statistically significant effect sizes for independent living skills ( $Z = 2.95$ ,  $p = 0.003$ ), nonverbal communication ( $Z = 2.12$ ,  $p =$

0.03) and social skills/functioning ( $Z = 3.61, p < 0.001$ ). Some subdomains represented by only one or two cases may have been underpowered to pick up significant effects.

### 3.5 Clinical Characteristics

Studies varied in their diagnosis of either schizophrenia only ( $N = 9$  cases,  $\delta = .10$ , 95% CI  $-0.38 < \delta < 0.58$ ) or mixed ( $N = 13$  cases,  $\delta = .40$ , 95% CI  $0.16 < \delta < 0.64$ ) groups with schizophrenia/schizoaffective disorder. Further analysis revealed that there were no differences between mixed and schizophrenia-only groups ( $Q_B[1] = 1.17, p = 0.28$ ). There were insufficient cases ( $n=1$ ) to examine the impact of including a psychosis-NOS group.

We also examined impact of age at illness onset, which was not significant ( $Z = 0.36, p = 0.72$ ), but there were only four cases that reported this variable. More cases reported duration of illness, which was also not a significant moderator ( $N = 14$  cases,  $Z = 0.83, p=0.40$ ).

The impact of setting was reported in 8 cases in which all patients were inpatients (95% CI  $-0.01 < \delta < 0.39$ ), 15 with outpatients (95% CI  $0.24 < \delta < 0.52$ ) and 9 mixed-setting cases (95% CI  $-0.26 < \delta < 0.45$ ). The effect of study setting was marginally non-significant ( $Q_B[2]=5.94, p=0.051$ ).

Effect sizes did differ by symptoms when examined using the SANS ( $N = 3$  cases,  $Z = -3.07, p = 0.002$ ) or the SAPS ( $N = 3$  cases,  $Z = -3.17, p = 0.002$ ), but these analyses represented only three cases each. There were more cases that reported PANSS scores ( $N = 10$  cases,  $Z = -3.20, p = 0.001$ ), indicating that overall symptomatology was a significant moderator of study effect. Patient anti-psychotic medication status was reported in 11 cases in which all patients were 100% medicated (95% CI  $-0.22 < \delta < 0.61$ ) and 6 cases with partial antipsychotic use (95% CI  $0.17 < \delta < 0.81$ ) and were not significant ( $Q_B[2]=1.22, p=.54$ ).

### 3.6 Demographic Characteristics

Several demographic variables believed to influence EP abilities were analyzed. For sex effects, percentage of males patients in a sample ( $N = 23$  cases) was positively correlated with effect sizes ( $Z = 2.28, p = 0.02$ ). Race, as reflected by the percentage of Caucasians in a sample, was negatively associated with effect sizes ( $N = 14, Z = -2.20, p = 0.027$ ). Patient age ( $N = 24$  cases) and patient education ( $N = 9$  cases) were not significant moderators of effect sizes ( $p$ 's = 0.15 and 0.73 respectively). Marital status, identified by percentage of patients who were ever married ( $N = 6$  cases), did not impact effect sizes ( $Z = -0.89, p = 0.37$ ).

### 3.7 Visual versus Auditory Emotion Perception Tasks

Differences in task type were analyzed for cases that presented visual ( $N = 17$  cases,  $\delta = 0.23$ , 95% CI  $-0.02 < \delta < 0.48$ ), auditory ( $N = 2$  cases,  $\delta = 0.65$ , 95% CI  $-0.98 < \delta < 2.28$ ) or mixed ( $N = 4$  cases,  $\delta = 0.59$ , 95% CI  $0.12 < \delta < 1.06$ ) stimuli and were not significant ( $Q_B[2]=1.98, p = .37$ ).

## 4. Conclusions

A considerable literature has established the presence of large EP deficits in schizophrenia (C.G. Kohler et al., 2010) and while it appeared that these EP deficits impact functional outcomes (Couture et al., 2006), effect magnitude has been unclear. Our meta-analysis of 25 articles showed a significant relationship between EP and functional outcomes in individuals with schizophrenia or schizoaffective disorder, with effect sizes in the medium range. There

was no evidence of publication bias and the ‘file drawer’ problem, which is a limitation of some meta-analyses, was negligible.

#### 4.1 Emotion Perception and Functional Outcomes

Effects sizes for the relationship between EP and functional outcomes were heterogeneous, indicating the need to further examine key moderating methodological, clinical or demographic factors. Examination of the impact of type of task used to evaluate EP indicated that it was a significant moderator. Specifically, improved performance on emotion differentiation tasks did not impact functional outcomes, but it is worth noting that this analysis may have been underpowered. Importantly, emotion identification tasks were associated with heterogeneous, medium range effect sizes ( $d = 0.36$ ). We then found large, positive relationships between emotion identification and functional outcome domains involving social problem solving and social skills. This relationship between accurately identifying emotions in faces and voices, and efficiently navigating the social environment indicates that these abilities could be useful treatment targets. For instance, teaching patients to recognize emotions, generate solutions to everyday social problems and develop social interactional skills (e.g. eye contact) could help maximize social functioning in the real world. This was further evident in medium range associations noted within community functioning, which is an indirect indicator of everyday functioning skills such as independent living, nonverbal communication and interpersonal social skills.

#### 4.2 Demographic and Clinical Moderators

The strength of the association between emotion identification and functional outcomes was independent of age, education, marital status, age of onset, duration of illness, medication status, type of diagnosis, setting or visual/auditory task format. There were, however, three significant demographic and clinical moderators. These were sex, race and clinical symptoms. The percentage of males in a sample significantly moderated emotion identification-outcome relationships, with stronger associations observed for males. Sex differences in EP abilities have been previously demonstrated, with male patients showing greater deficits, especially in identifying happy and sad expressions (Carter et al., 2009). Sex differences in negative symptomology has also been documented (Gur, Petty, Turetsky, & Gur, 1996) and may influence better illness trajectories and outcomes in females with schizophrenia (Angermeyer, Goldstein, & Kuehn, 1989). These results indicate that since emotion perception deficits are more strongly associated with outcomes in males, males may be more likely to benefit from treatment interventions targeting these deficits.

Race was also a significant moderator, with weaker emotion-function associations observed in samples with a large percentage of Caucasians. The impact of same versus other-race effects on EP has been examined previously (Pinkham et al., 2008) and it appears that while there are universal affect programs (Ekman & Friesen, 1971), there are also subtle behavioral and neural differences in the perception of emotional faces as a function of race (Elfenbein & Ambady, 2003a, 2003b; Lee et al., 2008). While the current findings suggest that there may be a differential impact of race on emotion identification ability and functional outcomes, it is worth noting that the percentage of Caucasians present in the source studies far outweighed racial group representation. The grouping of several disparate ethnicities together diminished our ability to more closely examine the potentially dynamic interplay between race/ethnicity and outcomes. Future studies will need to pay closer attention to recruitment of diverse samples and distinctly report findings on the diversity of racial and ethnic groups represented in schizophrenia.

Interestingly, fewer negative and positive symptoms were associated with stronger relationships between emotion identification and outcomes. Previous work on the influence

of symptoms such as paranoia on EP has provided conflicting results. Nonparanoid schizophrenia has been associated with greater impairments in emotion perception than paranoid schizophrenia (Chan et al., 2008; Davis and Gibson, 2000; Lewis and Garver, 1995; Phillips et al., 1999). Yet, others suggested the opposite pattern, with worse perception of negative emotions (An et al., 2006) and abnormal neural activity, particularly in amygdala, in response to emotional stimuli in patients with paranoid schizophrenia (Williams et al., 2007; Russell et al., 2007). Higher levels of symptoms are associated with longer durations of hospitalization, increased overall symptoms, decreased ability to meet basic needs, and decreased quality of work (Siegel et al., 2006). The results from our analysis indicate that efforts geared towards increasing clinical stability may decrease the strength of the impact of EP deficits on functional outcomes. In other words, less symptomatic patients may be more likely to derive functional benefits from EP based interventions, which is consistent with expectations regarding patients' participation in treatment protocols.

### 4.3. Limitations

There are limitations of this study worthy of discussion. First, underreporting of variables by the source studies (e.g. emotion differentiation tasks, race, age of onset, auditory tasks) limited the ability to detect significant relationships that may be relevant for emotionoutcome relationships. Future studies need to consider evaluating and reporting these variables to allow closer examination of these important moderators. Second, the cross-sectional associations presented here describe relationships between EP and outcomes at a single time point and do not clarify longitudinal associations. Related to this, it is worth noting that while emotion identification may influence outcomes, it is also possible that outcomes may impact emotion identification abilities. For example, negative social experiences may influence the extent to which a person scans key emotional features of the face (e.g. eyes, mouth), which might then impact the ability to interact efficiently in a social situation. Thus, these data support correlations between emotion identification and functional outcomes, but cannot make claims about causation. Ultimately, a meta-analysis can never be more valid than the primary studies that it is aggregating and future studies are urged to use and report detailed methods of data collection and analysis to increase internal validity and enable proper representation of the literature being analyzed.

### 4.4. Conclusions

These limitations notwithstanding, our results indicate the presence of a significant relationship between emotion identification abilities and functional outcomes that are mediated by factors such as sex, race and clinical symptoms. Since the results of this meta-analysis indicate that emotion identification deficits are moderately correlated with social and functional outcomes, there are treatment implications. Remediation efforts that target these deficits may improve functional outcomes in schizophrenia. This may be particularly valuable for ongoing early-intervention efforts since early improvement of EP abilities may reduce the individual, familial and societal burden associated with schizophrenia.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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### References

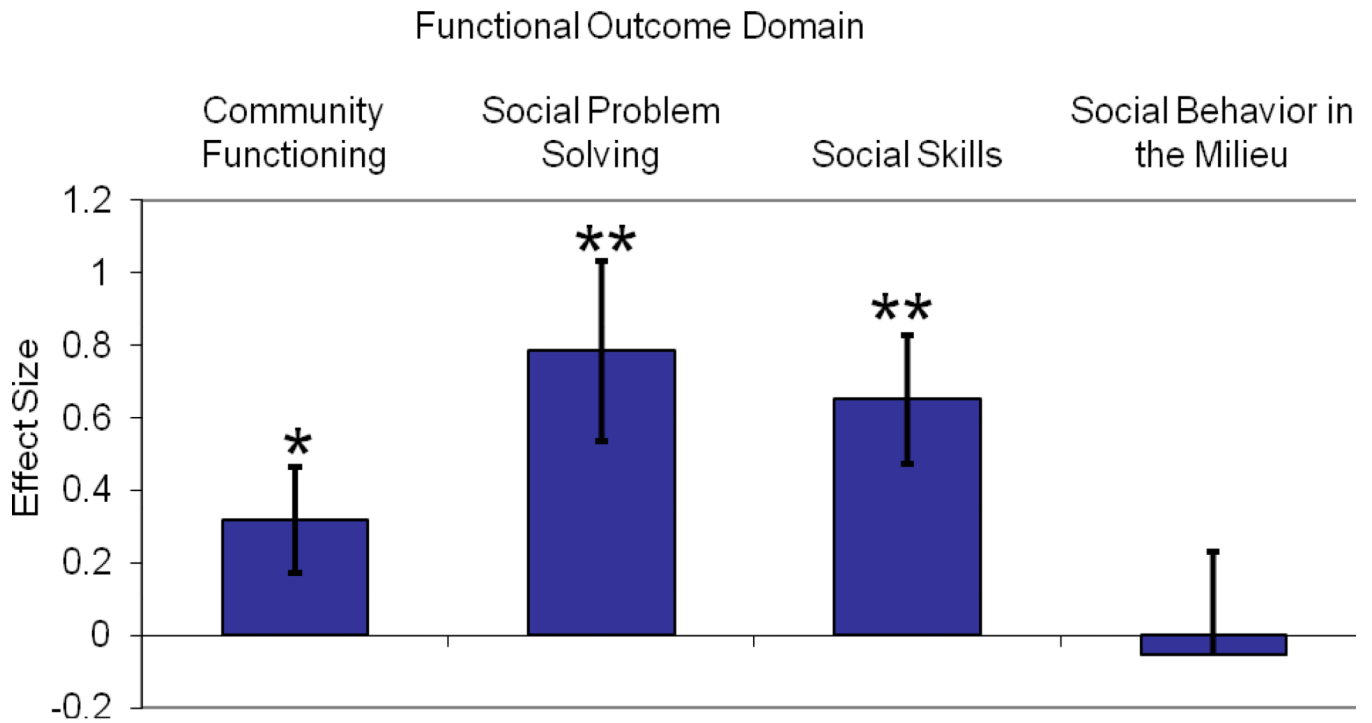
- Andreasen, NC. Scale for the Assessment of Negative Symptoms (SANS). Iowa City, IA: University of Iowa; 1984a.
- Andreasen, NC. Scale for the Assessment of Positive Symptoms (SAPS). Iowa City, IA: University of Iowa; 1984b.
- Angermeyer MC, Goldstein JM, Kuehn L. Gender differences in schizophrenia: rehospitalization and community survival. *Psychol Med*. 1989; 19(2):365–382. [PubMed: 2762441]
- Baslet G, Termini L, Herbener E. Deficits in emotional awareness in schizophrenia and their relationship with other measures of functioning. *J Nerv Ment Dis*. 2009; 197(9):655–660. doi: 10.1097/NMD.0b013e3181b3b20f 00005053-200909000-00003 [pii]. [PubMed: 19752644]
- Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. *Biometrics*. 1994; 50:1088–1101. [PubMed: 7786990]
- Borenstein, M.; Hedges, L.; Higgins, J.; Rothstein, H. *Comprehensive Meta-Analysis*. Englewood, NJ: Biostat; 2005.
- Calkins ME, Tepper P, Gur RC, Ragland JD, Klei L, Wiener HW, Gur RE. Project among African-Americans to explore risks for schizophrenia (PAARTNERS): evidence for impairment and heritability of neurocognitive functioning in families of schizophrenia patients. *Am J Psychiatry*. 2010; 167(4):459–472. doi: appi.ajp.2009.08091351 [pii] 10.1176/appi.ajp.2009.08091351. [PubMed: 20194479]
- Carter CS, Barch DM, Gur R, Gur R, Pinkham A, Ochsner K. CNTRICS Final Task Selection: Social Cognitive and Affective Neuroscience, ÆiBased Measures. *Schizophrenia bulletin*. 2009; 35(1): 153–162. doi: 10.1093/schbul/sbn157. [PubMed: 19011231]
- Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
- Combs DR, Chapman D, Waguspack J, Basso MR, Penn DL. Attention shaping as a means to improve emotion perception deficits in outpatients with schizophrenia and impaired controls. *Schizophr Res*. (in press). doi: S0920-9964-(10)01307-1 [pii] 10.1016/j.schres.2010.05.011.
- Combs DR, Tosheva A, Penn DL, Basso MR, Wanner JL, Laib K. Attentional-shaping as a means to improve emotion perception deficits in schizophrenia. *Schizophr Res*. 2008; 105(1–3):68–77. doi: S0920-9964(08)00245-4 [pii] 10.1016/j.schres.2008.05.018. [PubMed: 18585899]
- Combs DR, Tosheva A, Wanner J, Basso MR. Remediation of emotion perception deficits in schizophrenia: the use of attentional prompts. *Schizophr Res*. 2006; 87(1–3):340–341. doi: S0920-9964(06)00227-1 [pii] 10.1016/j.schres.2006.05.003. [PubMed: 16809024]
- Couture SM, Penn DL, Roberts DL. The functional significance of social cognition in schizophrenia: a review. *Schizophr Bull*. 2006; 32(Suppl 1):S44–S63. doi: sb1029 [pii] 10.1093/schbul/sb1029. [PubMed: 16916889]
- Darwin, C. *The expression of emotions in man and animals*. Chicago: University of Chicago Press; 1965.
- 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. [PubMed: 12214327]
- Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ*. 1997; 315(7109):629–634. [PubMed: 9310563]
- Ekman P, Friesen WV. Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology*. 1971; 17(2):124–129. doi: 10.1037/h0030377. [PubMed: 5542557]
- Elfenbein HA, Ambady N. Universals and Cultural Differences in Recognizing Emotions. *Current Directions in Psychological Science*. 2003a; 12(5):159–164. doi: 10.1111/1467-8721.01252.



- Elfenbein HA, Ambady N. When familiarity breeds accuracy: Cultural exposure and facial emotion recognition. *Journal of Personality and Social Psychology*. 2003b; 85(2):276–290. doi: 10.1037/0022-3514.85.2.276. [PubMed: 12916570]
- Fett AJ, Viechtbauer W, Domingueza M, Penn DL, Van Os J, L K. The relationship between neurocognition and social cognition with functional outcomes in schizophrenia: A meta-analysis. *Neurosci. Biobehav. Rev.* (in press).
- Fiszdon JM, Johannesen JK. Functional significance of preserved affect recognition in schizophrenia. *Psychiatry Res*. 2010; 176(2–3):120–125. doi: S0165-1781(09)00310-2 [pii] 10.1016/j.psychres.2009.08.006. [PubMed: 20202689]
- Frommann N, Streit M, Wölwer W. Remediation of facial affect recognition impairments in patients with schizophrenia: a new training program. *Psychiatry Research*. 2003; 117(3):281–284. [PubMed: 12686371]
- Green MF, Olivier B, Crawley JN, Penn DL, Silverstein S. Social Cognition in Schizophrenia: Recommendations from the Measurement and Treatment Research to Improve Cognition in Schizophrenia New Approaches Conference. *Schizophrenia Bulletin*. 2005; 31(4):882–887. doi: 10.1093/schbul/sbi049. [PubMed: 16135561]
- Green MF, Penn DL, Bental R, Carpenter WT, Gaebel W, Gur RC, Heinssen R. Social cognition in schizophrenia: an NIMH workshop on definitions, assessment, and research opportunities. *Schizophr Bull*. 2008; 34(6):1211–1220. doi: sbm145 [pii] 10.1093/schbul/sbm145. [PubMed: 18184635]
- Gur RE, Kohler CG, Ragland JD, Siegel SJ, Lesko K, Bilker WB, Gur RC. Flat affect in schizophrenia: relation to emotion processing and neurocognitive measures. *Schizophr Bull*. 2006; 32(2):279–287. doi: sbj041 [pii] 10.1093/schbul/sbj041. [PubMed: 16452608]
- Gur RE, Petty RG, Turetsky BI, Gur RC. Schizophrenia throughout life: sex differences in severity and profile of symptoms. *Schizophr Res*. 1996; 21(1):1–12. doi: 0920996496000230 [pii]. [PubMed: 8864248]
- Harvey PD, Patterson TL, Potter LS, Zhong K, Brecher M. Improvement in Social Competence With Short-Term Atypical Antipsychotic Treatment: A Randomized, Double-Blind Comparison of Quetiapine Versus Risperidone for Social Competence, Social Cognition, and Neuropsychological Functioning. *Am J Psychiatry*. 2006; 163(11):1918–1925. doi: 10.1176/appi.ajp.163.11.1918. [PubMed: 17074943]
- Hedges, L.; Olkin, I. *Statistical methods for meta-analysis*. New York: Academic Press; 1985.
- Hofer A, Benecke C, Edlinger M, Huber R, Kemmler G, Rettenbacher MA, Wolfgang Fleischhacker W. Facial emotion recognition and its relationship to symptomatic, subjective, and functional outcomes in outpatients with chronic schizophrenia. *Eur Psychiatry*. 2009; 24(1):27–32. doi: S0924-9338(08)01574-5 [pii] 10.1016/j.eurpsy.2008.06.008. [PubMed: 18774270]
- Horan WP, Blanchard JJ. Neurocognitive, social, and emotional dysfunction in deficit syndrome schizophrenia. *Schizophr Res*. 2003; 65(2–3):125–137. doi: S0920996402004103 [pii]. [PubMed: 14630305]
- Horan WP, Kern RS, Shokat-Fadai K, Sergi MJ, Wynn JK, Green MF. Social cognitive skills training in schizophrenia: an initial efficacy study of stabilized outpatients. *Schizophr Res*. 2009; 107(1): 47–54. doi: S0920-9964(08)00414-3 [pii] 10.1016/j.schres.2008.09.006. [PubMed: 18930378]
- Irani F, Brensinger CM, Richard J, Calkins ME, Moberg PJ, Bilker WB, Gur RC. Computerized Neurocognitive Test Performance in Schizophrenia: A Lifespan Analysis. *American Journal of Geriatric Psychiatry*. (in press).
- Kay SR, Fiszbein A, Opler LA. The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophr Bull*. 1987; 13(2):261–276. [PubMed: 3616518]
- Kohler CG, Martin EA. Emotional processing in schizophrenia. *Cogn Neuropsychiatry*. 2006; 11(3): 250–271. doi: 769903919 [pii] 10.1080/13546800500188575. [PubMed: 17354071]
- Kohler CG, Walker JB, Martin EA, Healey KM, Moberg PJ. Facial Emotion Perception in Schizophrenia: A Meta-analytic Review. *Schizophrenia Bulletin*. 2010; 36(5):1009–1019. doi: 10.1093/schbul/sbn192. [PubMed: 19329561]

- Kring AM, Kerr SL, Smith DA, Neale JM. Flat affect in schizophrenia does not reflect diminished subjective experience of emotion. *Journal of Abnormal Psychology*. 1993; 102(4):507–517. doi: 10.1037/0021-843x.102.4.507. [PubMed: 8282918]
- Lee KU, Khang HS, Kim KT, Kim YJ, Kweon YS, Shin YW, Liberzon I. Distinct processing of facial emotion of own-race versus other-race. *Neuroreport*. 2008; 19(10):1021–1025. doi: 10.1097/WNR.0b013e3283052df2.00001756-200807020-00005 [pii]. [PubMed: 18580572]
- Mandal MK, Pandey R, Prasad AB. Facial Expressions of Emotions and Schizophrenia: A Review. *Schizophrenia Bulletin*. 1998; 24(3):399–412. [PubMed: 9718632]
- Mehl S, Rief W, Mink K, Lullmann E, Lincoln TM. Social performance is more closely associated with theory of mind and autobiographical memory than with psychopathological symptoms in clinically stable patients with schizophrenia-spectrum disorders. *Psychiatry Res*. 2010; 178(2): 276–283. doi: S0165-1781(09)00382-5 [pii] 10.1016/j.psychres.2009.10.004. [PubMed: 20494454]
- Morrison RL, Bellack AS, Mueser KT. Deficits in Facial-Affect Recognition and Schizophrenia. *Schizophrenia Bulletin*. 1988; 14(1):67–83. [PubMed: 3291095]
- Mueser KT, Doonan R, Penn DL, Blanchard JJ, Bellack AS, Nishith P, DeLeon J. Emotion recognition and social competence in chronic schizophrenia. *J Abnorm Psychol*. 1996; 105(2):271–275. [PubMed: 8723008]
- Pan YJ, Chen SH, Chen WJ, Liu SK. Affect recognition as an independent social function determinant in schizophrenia. *Compr Psychiatry*. 2009; 50(5):443–452. doi: S0010-440X(08)00169-7 [pii] 10.1016/j.comppsy.2008.11.003. [PubMed: 19683615]
- Penn DL, Combs D. Modification of affect perception deficits in schizophrenia. *Schizophrenia Research*. 2000; 46(2):217–229. [PubMed: 11120434]
- Penn DL, Keefe RSE, Davis SM, Meyer PS, Perkins DO, Losardo D, Lieberman JA. The effects of antipsychotic medications on emotion perception in patients with chronic schizophrenia in the CATIE trial. *Schizophrenia Research*. 2009; 115(1):17–23. [PubMed: 19766459]
- Phillips LK, Seidman LJ. Emotion Processing in Persons at Risk for Schizophrenia. *Schizophrenia Bulletin*. 2008; 34(5):888–903. doi: 10.1093/schbul/sbn085. [PubMed: 18644853]
- Pijnenborg GHM, Withaar FK, Evans JJ, Van den Bosch RJ, Timmerman ME, Brouwer WH. The predictive value of measures of social cognition for community functioning in schizophrenia: implications for neuropsychological assessment. *Journal of the International Neuropsychological Society*. 2009; 15:239–247. [PubMed: 19203437]
- Pinkham AE, Penn DL, Perkins DO, Graham KA, Siegel M. Emotion perception and social skill over the course of psychosis: a comparison of individuals "at-risk" for psychosis and individuals with early and chronic schizophrenia spectrum illness. *Cogn Neuropsychiatry*. 2007; 12(3):198–212. doi: 777075857 [pii] 10.1080/13546800600985557. [PubMed: 17453901]
- Pinkham AE, Sasson NJ, Calkins ME, Richard J, Hughett P, Gur RE, Gur RC. The other-race effect in face processing among African American and Caucasian individuals with schizophrenia. [Research Support NIH. Extramural]. *Am J Psychiatry*. 2008; 165(5):639–645. doi: 10.1176/appi.ajp.2007.07101604. [PubMed: 18347000]
- Poole JH, Tobias FC, Vinogradov S. The functional relevance of affect recognition errors in schizophrenia. *J Int Neuropsychol Soc*. 2000; 6(6):649–658. [PubMed: 11011511]
- Russell TA, Chu E, Phillips ML. A pilot study to investigate the effectiveness of emotion recognition remediation in schizophrenia using the micro-expression training tool. *British Journal of Clinical Psychology*. 2006; 45:579–583. [PubMed: 17076965]
- Russell TA, Green MJ, Simpson I, Coltheart M. Remediation of facial emotion perception in schizophrenia: concomitant changes in visual attention. *Schizophr Res*. 2008; 103(1–3):248–256. doi: S0920-9964(08)00220-X [pii] 10.1016/j.schres.2008.04.033. [PubMed: 18565733]
- Sergi MJ, Green MF, Widmark C, Reist C, Erhart S, Braff DL, Mintz J. Cognition and neurocognition: Effects of risperidone, olanzapine, and haloperidol. *American Journal of Psychiatry*. 2007; 164(10):1585–1592. [PubMed: 17898351]
- Siegel SJ, Irani F, Brensinger CM, Kohler CG, Bilker WB, Ragland JD, Gur RE. Prognostic Variables at Intake and Long-Term Level of Function in Schizophrenia. *Am J Psychiatry*. 2006; 163(3):433–441. doi: 10.1176/appi.ajp.163.3.433. [PubMed: 16513864]

- Silver H, Goodman C, Knoll G, Isakov V. Brief emotion training improves recognition of facial emotions in chronic schizophrenia. A pilot study. *Psychiatry Research*. 2004; 128(2):147–154. [PubMed: 15488957]
- Stewart SL, Corcoran R, Drake RJ. Mental state references in psychosis: a pilot study of prompted implicit mentalising during dialogue and its relationship with social functioning. *Cogn Neuropsychiatry*. 2009; 14(1):53–75. doi: 908690269 [pii] 10.1080/13546800902743449. [PubMed: 19214842]
- Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, Thacker SB. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *JAMA*. 2000; 283(15):2008–2012. doi: jst00003 [pii]. [PubMed: 10789670]
- Tso IF, Grove TB, Taylor SF. Emotional experience predicts social adjustment independent of neurocognition and social cognition in schizophrenia. *Schizophr Res*. 2010; 122(1–3):156–163. doi: S0920-9964(09)00597-0 [pii] 10.1016/j.schres.2009.12.007. [PubMed: 20051314]
- Wolwer W, Frommann N, Halfmann S, Piaszek A, Streit M, Gaebel W. Remediation of impairments in facial affect recognition in schizophrenia: Efficacy and specificity of a new training program. *Schizophrenia Research*. 2005; 80(2):295–303. [PubMed: 16125367]



\*  $p < 0.05$

\*\*  $p < 0.005$

**Figure 1.**  
Effect sizes for Emotion Identification and Functional Outcome Domains

