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CNTRICS Final Task Selection: Social Cognitive and Affective Neuroscience–Based Measures

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This article describes the results and recommendations of the third Cognitive Neuroscience Treatment Research to Improve Cognition in Schizophrenia meeting related to measuring treatment effects on social and affective processing. At the first meeting, it was recommended that measurement development focuses on the construct of emotion identification and responding. Five Tasks were nominated as candidate measures for this construct via the premeeting web-based survey. Two of the 5 tasks were recommended for immediate translation, the Penn Emotion Recognition Task and the Facial Affect Recognition and the Effects of Situational Context, which provides a measure of emotion identification and responding as well as a related, higher level construct, context-based modulation of emotional responding. This article summarizes the criteria-based, consensus building analysis of each nominated task that led to these 2 paradigms being recommended as priority tasks for development as measures of treatment effects on negative symptoms in schizophrenia.

Key words: social and emotional processing/ schizophrenia/CNTRICS

In addition to "cold" cognitive deficits, people with schizophrenia often appear to have prominent deficits in social and emotional processing. For example, negative symptoms are core elements of the disorder, often emerging during the prodromal phase of the illness as a grim harbinger of the social disability that is a hallmark of the chronic phase of the illness. Like cold cognitive deficits, negative symptoms are associated with functional disability and reduced quality of life and are largely treatment refractory.[1] Our conceptualization of negative symptoms and views regarding the underlying neurobiology have been increasingly informed both by empirical data and by a rapid grown of our understanding of normal social and emotional processing.[2] In addition to negative symptoms, many people with schizophrenia have significant problems with complex social interactions, and this has led many investigators to seek to understand these deficits using the emerging set of tools and constructs from social cognitive and affective neuroscience (SCAN) where it is generally considered that a set of more or less unique cognitive and neural systems support these functions.

During the first Cognitive Neuroscience Treatment Research to Improve Cognition in Schizophrenia (CNTRICS) meeting in Bethesda, MD, in February, 2007, the state of the field of SCAN was reviewed by Ochsner[3] and other experts in the field. This perspective and its relevance for understanding negative symptoms of schizophrenia have previously been published. One of the more striking aspects of this first step in the CNTRICS process was the evolution of thinking among clinical and translational research participants in the context of this intensive exploration of the basic science of cognitive and emotional processing. This process resulted in a substantial reconceptualization of the mechanisms most relevant for targeting for treatment in schizophrenia, and the domain of SCAN was no exception. For a detailed description of this meeting, including the use of web-based surveys, framing talks by basic scientists, and consensus building discussions that led to a set of target constructs/ cognitive systems for treatment development in schizophrenia, see Carter et al.[4] An important factor in settling on target constructs in schizophrenia at the time of this first meeting was that the SCAN field itself was itself in an early phase of development. A number of important elements, identified in the social and emotional "stream" model of Ochsner, were recognized as potentially highly relevant to schizophrenia but poorly understood in healthy people and in great need of more basic research. Therefore, of the 5 elements of social and emotional processing identified, just 2 were deemed ready for immediate development. These were (1) the acquisition of emotional value and meaning and (2) emotional identification and responding. During the third meeting, the

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acquisition of emotional value and meaning was considered under long-term memory (reinforcement learning). This article focuses on discussions related to the recommendation of tasks for further development that measure emotion identification and responding and the related construct of context-based modulation of emotional responding. Low-level and high-level simulation of others' mental states and self/other evaluation, which were seen as highly promising, were also seen as in need of further basic research as well as further research in schizophrenia prior to being recommended for measurement development for treatment research in the illness. For a full discussion of these issues, see Ochsner.[3]

The targeted construct of emotion identification and responding is defined as the ability to detect, recognize, and judge the affective value of both linguistic (eg, seen or spoken words and their prosodic contour) and nonlinguistic (eg, images of people, facial expressions, eye gaze, scenes) stimuli. Five paradigms were submitted through the web-based survey as candidate measures of this construct. These tasks were

- The Perceiving Emotion Using Light Walkers Task
- The Multimorph Task
- The Reading the Mind in the Eyes measures for this construct. These tasks were
- The Penn Emotion Recognition Task
- The Facial Affect Recognition and the Effects of Situational Context

These tasks were nominated through a web-based survey process. This web-based survey process together with a description of the attendees, framing talks by basic cognitive neuroscientists, consensus building discussions, and criterion-based decision making that occurred at the meeting, are described in detail in the overview article[5] at the beginning of this special volume. In the present article, we describe each of the 5 tasks that were considered at the meeting, using the criteria developed through the web-based survey and applied at the meeting in order to evaluate the nominated tasks and arrive at specific recommendations for those that should be immediately targeted for further development and optimization. We sought at this meeting to identify 2 tasks per construct to recommend for further development for the measurement of treatment effects. This further development could include optimizing the tasks to detect differences between schizophrenia patients and healthy individuals while maintaining construct validity, optimizing the psychometric properties of the tasks, as well as further evaluation of sensitivity to treatment effects. Of the 5 nominated tasks, the 2 that were nominated were the Penn Emotion Recognition Paradigm and the Facial Affect Recognition with the Effects of Situational Context Tasks. None of the tasks recommended should be considered as being fully optimized at this time. Their further development and optimization is expected to lead to the availability of reliable and valid measures of impaired social and emotional processing in schizophrenia that, when successfully targeted for treatment, will have a high likelihood of improving functional outcome in the illness. Those tasks that were not nominated (Perceiving Light Walters, Multimorph, and Perceiving Mind in the Eyes tasks) were all deemed promising measures for the future but were not recommended based upon the criteria-based consensus building discussions in the breakout group at the meeting for reasons detailed in the paragraphs below.

The first nominated paradigm, Perceiving Emotion Using Light Walkers Task, is a modification of the one described by Heberlein et al[6]. In this task, the stimulus set consists of 50 clips illustrating human movement via point-light walkers. Each clip represents 1 of 5 emotional states (10 clips each of fear, anger, happiness, sadness, or neutral). Clips are presented, and participants are asked to decide which of 5 emotional states best represents the movement depicted. The 5 terms (fear, anger, happiness, sadness, or neutral) are presented on the screen immediately after the clip, and the subject verbally indicates their choice aloud, which will be entered by the tester. Accuracy and voice-activated reaction time are collected for each clip, and accuracy is the primary dependent variable. This novel paradigm was seen as having potential for further development. It was rated as having high construct validity. Some potential was also seen for the development of a possible animal model. Weaknesses included relatively low clarity of the neural systems and cognitive mechanisms involved in the task, a lack of pharmacological data, limited and in fact mixed data regarding performance in schizophrenia patients,[7,8] and a lack at this time of psychometric data. Due to the need for additional data, this paradigm was not nominated for priority development by the breakout group.

The second paradigm nominated through the web-based survey and evaluated by the breakout group was the Multimorph Task. This paradigm, described in Coupland et al,[9] uses images from the Pictures of Facial Affect series in which the intensity of emotion has been morphed to produce continua between neutral and the full expression of 6 emotions (happy, surprised, fearful, sad, disgusted, and angry). The rationale for using this approach is 2-fold. First, rather than simply assigning correct/incorrect responses, it allows parametric designs that include intensity as a variable. Second, the base images in the series were originally selected to give high rates of correct responding in healthy subjects. This may give rise to ceiling effects for the base images that would prevent the detection of enhanced recognition of facial emotions. Nine models each show the 6 emotions, giving 54 stimuli. For each stimulus, the expression was morphed from neutral to 100% in 40 increments of 2.5%. The stimuli are presented as continuous sequences

in which the emotion transformed over 20 s from 2.5% to 100% at a rate of 5% per sec. The full 20-s progression is always presented. Subjects respond by clicking on-screen labels. The stimulus order and label positions are both randomized. Subjects are instructed to respond as soon as they identify the emotion without waiting until they are completely certain and can change their response at any time later by clicking on a different label. The lowest intensity is recorded at which each stimulus is recognized correctly before the end of the stimulus run and without subsequent alteration. Subjects make a final choice at full intensity, if they have not previously responded. An incorrect final choice is assigned 102.5% intensity. For example, if a subject responds incorrectly with "surprise" to a fear stimulus at 50% intensity, but then correctly at 80% intensity without subsequent changes, the threshold is 80%. If they respond correctly with surprise to a surprise stimulus at 50% and then change to "fear" at 80% without subsequent changes, the threshold is 102.5%. Mean identification thresholds are computed for each emotion from the 9 models.

This paradigm was evaluated as having good construct validity but very little clarity regarding underlying cognitive and neural mechanisms. For example, it does not distinguish the influence of response bias, which may differ in schizophrenia, from specific differences in the evaluation of affect. It was also felt that the development of a valid animal model was unlikely. A strength is that there are links to pharmacology, with diazepam impairing performance[10,11] and pharmacogenetics (5-hyomasty traytaarine depletion impairs performance in certain genetic polymorphisms).[12] There is limited evidence that performance on the task is impaired in schizophrenia[13] and a need for data regarding the psychometric properties of the task, with concerns regarding ceiling effects in controls as noted above. This task was not recommended for immediate development.

The third paradigm that was evaluated by the breakout group was the Reading the Mind in the Eyes Task.[14,15] This task measures the ability to perceive others' thinking or feeling based on examining only the eyes of another person presented in a still photograph. Unlike facial affect recognition, it does not rely on interpreting a configuration of features across different regions of the face. In this task, participants are asked to choose which words best describe what the person in the photograph thinks or feels based on the photograph of the eyes. To perform this task correctly, participants need to perceive the other persons' mental state based on the fragments of facial expression (ie, just the part of the face around eyes) and to decide which word best represents the thoughts or feelings expressed by the photograph. At the beginning of each trial, a blank screen with a fixation point appears for 500 ms. Photographs of eyes are presented at the center of the screen, along with adjectives at the bottom of the screen. Participants are asked to choose 1 of 4 adjectives that best describe what this person (represented by eyes) thinks or feels. Accuracy and voice-activated reaction time are measured for each trial, and the primary dependent measure is accuracy.

Although nominated as a measure of emotional identification and responding, this task was seen as ambiguous in terms of its construct validity, with many meeting participants seeing this task as having strong validity for a different construct, theory of mind. As such, the task was seen as having good clarity with regard to neural systems involved (eg, from imaging studies such as those by Cohen et al[16] and Calder et al[17]) but poor clarity with regard to the underlying cognitive mechanisms, which were felt to be in need of additional basic research. Strengths of the paradigm include its amenability to imaging studies; the development of animal models is likely to be very challenging. While there is some evidence for schizophrenia patients being impaired on the task[18–20] and even some very preliminary imaging data in schizophrenia using this task,[21] there are no psychometric data or links to pharmacology. The task was not recommended for immediate development as a measure of treatment effects in schizophrenia, primarily because of the lack of construct validity concern.

Two paradigms were selected as recommended for further development for measurement of treatment effects in schizophrenia as measures of the construct of emotional identification and responding. The first was the Penn Emotion Recognition Task. Following the criterion-based approach to evaluate each task, this paradigm was recommended as having (*a*) high construct validity, (*b*) a moderate degree of clarity of underlying neural systems based upon animal and lesion studies and human functional imaging studies, (*c*) somewhat less clarity with regard to the component cognitive mechanisms that are required to be engaged for successful performance, and (*d*) some potential for developing a valid animal model and strong evidence of impairment in schizophrenia with established links to functional outcome and reasonably well-established levels of suitable psychometric properties.

Penn Emotion Recognition Task

Task Description

The Penn Emotion Recognition Task (ER-40) assesses facial emotion recognition ability and includes 40 color photographs of faces expressing 4 basic emotions—happiness, sadness, anger, or fear—and neutral expressions. Stimuli are balanced for poser's gender, age, and ethnicity, and for each emotion category, 4 high-intensity and 4 low-intensity expressions are included. Methods for obtaining facial expressions of posed and evoked emotions have been published.[22] All stimuli in the ER-40 represent evoked, or felt, emotions.

The ER-40 is a computerized measure designed in both PowerLaboratory and Macromedia Flash platforms, which allows testing either on dedicated hardware or through the internet. Participants are instructed to examine a series of faces and identify the expressed emotion from 5 possible choices. The task begins with a practice trial in which feedback is provided. If the participant's response is incorrect, she/he is informed of the correct answer and is directed back to the practice trial until a correct response is made. All other stimuli are presented in randomized order, and the average testing time is under 5 min.

An automated scoring program provides accuracy scores and median response times. A list of scoring variables, administration instructions, the task, and scoring programs, are available (http://webcnp.med.upenn.edu).

Construct Validity

Evidence for the construct validity of the ER-40 can be gleaned from comparing performance on the ER-40 to the literature on emotion recognition and by assessing how it relates to conceptually distinct cognitive processes. First, emotion recognition studies have consistently demonstrated that happiness is the most accurately identified emotion[23] and that accuracy of identification increases with increased intensity of expression.[24] These studies have also reported a slight gender difference that favors women.[25] Examination of data from 424 healthy individuals revealed that the ER-40 behaved in a manner largely consistent with these findings. Accuracy was greatest for happiness ($P < .0001$ for all comparisons), and extreme expressions were more accurately identified than mild expressions ($P < .0001$). Evidence for gender effects was mixed. Females were better than males on overall task performance ($P = .043$). However, this difference was driven by significant differences on happy ($P < .0001$) and sad ($P = .0157$) expressions only. Males and females did not differ on accuracy for angry, fearful, or neutral expressions. Second, partial correlations controlling for the effects of IQ demonstrate that accuracy scores on the ER-40 are more highly related to the EmoDiff (Spearman partial rho = .294, $P = .01$), another emotion recognition task assessing only happy and sad recognition, than to tasks assessing other cognitive abilities such as working memory (Spearman partial rho = .11, $P = .04$), motor skills (Spearman partial rho = .04, $P = .5$), and abstraction and mental flexibility (Spearman partial rho = .01, $P = .82$).

Neural Systems Supporting Task Performance

An increased number of studies have investigated the neural underpinnings of emotion processing. Complementary methods, including lesion and functional neuroimaging, have consistently demonstrated that a distributed neural network is required for emotion identification.[26–28] Components of this network include portions of the limbic system, primarily amygdala, hippocampus, and cingulate gyrus, as well as thalamus, regions of occipital cortex such as the fusiform gyrus, regions of the temporal cortex such as the superior temporal sulcus, and frontal regions such as the inferior frontal gyrus.

ER-40 stimuli have been utilized in several functional magnetic resonance imaging (fMRI) studies of emotion processing[29] and recognition.[30–33] These tasks have consistently elicited activation in the same regions noted above with particularly robust activations occurring in bilateral amygdala, hippocampus, thalamus, fusiform gyrus, and inferior frontal gyrus. Moreover, an analysis of neural activation during correct and incorrect emotion recognition with these stimuli has demonstrated that in healthy individuals correct identification of threat-related emotions (anger and fear) is associated with greater activation of the amygdala for anger and of the amygdala, fusiform gyrus, thalamus, middle frontal gyrus, and inferior frontal gyrus for fear. In contrast, for nonthreat-related emotions (happiness and sadness), incorrect identification is associated with increased activation of this network and, in particular, with increased activation of the thalamus for incorrect happy identifications and increased midfrontal regions for incorrect sad identifications.[32] Other laboratories have reported more robust activation for the ER-40 stimuli than for stimuli from the international affective picture scale[34] and for avatar faces.[33]

Pharamacological or Behavioral Manipulation of Task Performance

Within schizophrenia research, investigations of pharmacological influences on affect perception abilities have examined both first-generation and second-generation antipsychotic medications and have been limited both in number as well as in reported ameliorative effects.[35–37] These studies have utilized a variety of tasks, and none have used the ER-40; thus, it is unclear if the ER-40 would be sensitive to pharmacological effects. The ER-40 is used in several current clinical trials, and these studies will provide data on sensitivity to pharmacologic interventions. Results from behavioral interventions appear promising because several different intervention strategies have yielded significant improvements in emotion recognition. There is evidence that the ER-40 is sensitive to detecting changes in performance. Silver and colleagues[38] implemented a computerized emotion training program and utilized the ER-40 for pre- and postintervention assessment. Following the intervention, individuals with schizophrenia demonstrated significantly improved scores on the ER-40, suggesting that this task may be particularly informative for behavioral (and perhaps also for psychopharmacological) clinical trials.

Availability of an Animal Model

Animal models of emotion processing in healthy individuals and emotional blunting in schizophrenia support the

critical roles of the neural structures identified above. In a comprehensive review of animal studies, Phillips and colleagues[39] conclude that successful emotional processing depends on 2 neural systems: a ventral system comprised of amygdala, insula, ventral striatum, and ventral portions of the anterior cingulate gyrus and prefrontal cortex (PFC) and a dorsal system including the hippocampus and dorsal regions of the anterior cingulate gyrus and PFC. They suggest that the ventral system is integral to the identification of an emotional stimulus and the generation of an affective state in response to that stimulus while the dorsal system predominately works to regulate the produced emotional state. Similarly, based on results demonstrating that acute ketamine administration in rats significantly interferes with fear conditioning, Pietersen and colleagues[40] concluded that glutamatergic hypofunctioning in the amygdala may underlie deficits in fear processing and emotional blunting in schizophrenia. These findings may have implications for emotion recognition in schizophrenia because some (though not all) studies have suggested that negative symptoms including flat affect and emotional blunting are highly related to amygdala dysfunction and impaired emotion recognition abilities.[30,41,42]

Performance in Schizophrenia

The ER-40 has been used widely in investigations of emotion recognition impairments in schizophrenia and family members, including several current multisite studies investigating the genetic architecture of candidate endophenotypic markers of schizophrenia.[30,43,44] Initial results have demonstrated that the ER-40 shows good sensitivity to reduced performance in individuals with schizophrenia, with patients scoring on average 7% below healthy individuals (effect size 0.58).[45] Importantly, individuals with schizophrenia display other-race effects in face processing that are comparable to healthy individuals, which emphasize the necessity of including stimuli from varying ethnicities in face- and emotion-processing tasks.[45] Evidence for the potential of the ER-40 as an endophenotype has been obtained in family studies where significant heritability and intermediate performance of family members have been reported.[46]

Similarly, use of ER-40 stimuli in fMRI investigations of neural activation during emotion recognition has also demonstrated sensitivity to detect abnormalities in individuals with schizophrenia. Block design analyses have shown reductions in task-related activation of the neural network for facial affect processing in individuals with schizophrenia. Event-related analyses showed differential activation depending on whether participants responded correctly or incorrectly. For threat-related expressions (anger and fear), healthy people showed greater limbic activation associated with correct than with incorrect responses. However, when patients responded incorrectly to fearful stimuli, they showed paradoxically increased activation of that neural network. These increases were associated with greater severity of flat affect.[30]

Psychometric Properties

As identified in a previous CNTRICS report 5, the 3 most important test characteristics to preserve when translating tasks for clinical trials are test-retest reliability, construct validity, and the absence of floor and ceiling effects. While data are currently limited, an estimate of the test-retest reliability of the ER-40 in controls is .80 and in patients is .76, which falls within the identified acceptable range of .7–.9. Examinations of the distributions and mean performances of both healthy individuals and individuals with schizophrenia indicate that the ER-40 is free from both ceiling and floor effects. The mean percents correct for a sample of 424 healthy participants and 1023 patients were 84% and 73.1%, respectively. These values are consistent with the recommended optimal value of 25% difference from 100 to ensure the lack of ceiling effects and, given that the ER-40 is a forced choice paradigm, are sufficiently above 25% correct, which is the calculated floor value accounting for the number of choices and items if one were to perform at chance levels.

Future Directions

Current goals for continued development of the ER-40 are 2-fold. First, to enhance the ER-40's utility for clinical trials, an alternate form, the ER-40B, has been created and is currently undergoing validation. The ER-40B is matched item by item to the original task for emotion, intensity, gender, and race of stimuli. Second, efforts will continue to enhance the psychometric properties of the task. Item analyses will be conducted to isolate poor or inconsistent items, and additional data will be collected to more thoroughly assess test-retest reliability in both the ER-40 and ER-40B. Additional development needs to target the measurement of specific deficits in emotional face recognition rather than a generalized deficit. Schneider et al[47] included age discrimination and face recognition conditions in a modified version of this paradigm and showed relatively greater effects on emotional face recognition than the other 2 cognitive conditions, which also showed relatively lower performance. This design provided only partial support for the differential deficits claim because comparable discriminating power, rather than difficulty matching, is required for strong inference regarding the presence of a differential deficit. This approach does indicate the feasibility of developing the ER-40 for differential deficit measurement of emotional face recognition in schizophrenia.

A second, related paradigm that was felt to also provide a measure of this construct, as well as extending into the measurement of the use of context to modulate

emotional responses, was the Facial Affect Recognition and the Effects of Situational Context.

Facial Affect Recognition and the Effects of Situational Context

Description of the Task

The ability to recognize the emotion expressed in the human face is, perhaps, the most studied ability in social and affective neuroscience. Although studies to date have focused primarily on the recognition of facial expressions presented in isolation, it is clear that social situations provide powerful constraints on our perception of their meaning.[48–50] Importantly, the social situation provides important information about the event/stimulus that elicited a given facial expression, thereby providing a context for interpreting its meaning.

This task is a modification of the published methods of Kim et al,[51] who examined the use of sentence frames to bias perception of surprise expressions. Because fear and surprise are among the most highly confusable expressions, sentence frames can readily bias perception toward one face type or the other.[51,52] In the version of the task proposed in this article, all presentation conditions from Kim et al[51] are retained, with 3 exceptions.

First, Kim et al presented only trials where faces and contexts were presented together. Here we include both face-only and face + context trials. This allows percent correct recognitions on face-only trials to provide a baseline measure of facial emotion recognition against which the use of situational information on face + context trials can be evaluated. Second, Kim et al included only 2 types of sentence contexts—1 type describing a fear-relevant event (eg, ''a large dog ran towards her'') and 1 type describing a surprise-relevant event (eg, ''she heard a noise''). Here we include a third type of context that describes an emotion-irrelevant event (eg, ''she brushed her hair'') to control for general effects of context. Third, in addition to surprise faces, equal number of trials with true fear expressions and neutral expressions are used. This inclusion provides a measure of accuracy for recognizing truly fearful expressions as well as an additional condition for measuring the tendency to attribute emotion to neutral faces that often are perceived to be ambiguous.

Thus, the full task employs a 2 (trial type: face only or face + context) × 3 (type of context: fear, surprise, neutral) × 3 (type of face: fearful, surprised, neutral) that allows decomposition of main effects attributable to each variable as well as the interactions among them.

Construct Validity as a Measure of Affective Recognition and Evaluation

Because this is a new task used only in an imaging context to date, it has not undergone rigorous validity assessments. That being said, it can be treated as having 2 parts—basic affect recognition on face-only trials and the effects of context on recognition on face + context trials, and what we know about the validity of each measure can be considered separately.

Basic facial affect/emotion recognition is the most well studied of all abilities related to perceiving social and emotional stimuli (for reviews, see Vuilleumier and Pourtois,[27] Elfenbein and Ambday,[52] and Hennenlotter and Schroeder[53]). Because it is considered in some detail in the description of the Penn Emotion Recognition Task, we will mention only 2 additional considerations here. First, neuroscience can provide some data on the convergent validity of this measure: across a fairly wide range of presentation and judgment conditions—including those used in the present task—fearful facial expressions have been shown in imaging studies to reliably activate the amygdala, and in lesion studies, recognition of them is impaired by amygdala lesions. Second, studies conducted with individuals with schizophrenia provide some evidence for the discriminant and predictive validity of recognition facial expression of emotion: Measures of emotion recognition and measures of everyday social functioning correlate,[54–56] emotion recognition contributes variance to models of functional outcomes that is independent of nonsocial cognition,[43,54,57,58] and there is increasing evidence that measures of emotion recognition significantly mediate relationships between basic cognition on the one hand and community functioning on the other,[59–62] all of which would be expected if recognition is important for navigating the social world.

With respect to context effects, although experimental studies have shown consistent context effects on face perception, in particular,[48,49,63] and social perception more generally,[64] tests of convergent, discriminant, or predictive validity are not yet available.

Evidence for the Neural Systems that Support Task Performance

Although humans are able to recognize many facial expressions, this paradigm focuses on fear because the association of fear recognition with a specific brain system—the amygdala, as reviewed below—is among the most reliable findings in human lesion and imaging research. The amygdala is thought to rapidly encode stimuli, like fear expressions, that predict the presence of potential threats.[65,66] Recently, it has been shown that individuals with poor fear recognition ability show less activation of the amygdala to fear faces,[67] which further validates this task as an appropriate measure for this proposal. Although it is known to respond to arousing stimuli with both positive and negative value,[68] both imaging and lesion work have shown that the amygdala plays a special role in quickly recognizing social stimuli that signal the presence of potential threats, such as fearful

facial expressions,[69–71] as well as neutral faces that appear untrustworthy.[72–74] This response is influenced by individual differences in levels of anxiety or depression[75,76] and the presence of genes related to anxiety and mood disorders.[77] Importantly, the amygdala's response is modulated by perceptual cues that determine the social meaning of a facial expression, including the direction of eye gaze[78] and the size of the eye whites,[79,80] and may be important for recognizing the subtle social meanings conveyed by eye stimuli (eg, flirtation, boredom, interest) when presented alone.[81] In variants of the present paradigm, this modulation has been linked to activity in ventromedial PFC when a participant spontaneously perceives a surprise face to express fear[82] or when a prestimulus sentence frames the meaning of a surprise face as fear.[83] In keeping with this, in other paradigms, amygdala reactivity tracks a participant's perception that a facial stimulus expressed fear and not its actual physical attributes.[84] More generally, amygdala reactivity to emotional stimuli hinges critically on a participants appraisal or construal of the meaning of a stimulus and may be modulated by medial and lateral frontal regions that support changes in the cognitive interpretation one makes of it.[85]

Pharmacological or Behavioral Manipulation of Task Performance

The effects of pharmacological manipulations on performance of this task have not been investigated. Some research has examined the effects of pharmacological agents on the recognition of facial expressions in the absence of context, although the effects reported have not been particularly strong.[35] More generally, the effects on social cognitive measures of second-generation antipsychotic medications also have been somewhat inconsistent.[86,87] By contrast, behavior-based, nonpharmacological training in social cognitive skills has produced some improvement in emotion recognition and other related abilities.[88,89]

Availability of an Animal Model

Not applicable.

Performance in Schizophrenia

Performance on this task has not been assessed in schizophrenia. However, numerous studies have investigated basic emotion recognition using tasks akin to the face-only condition of the present paradigm. In these tasks, participants identify which emotion is being depicted in photos of individuals expressing a variety of emotions. Reviews of studies conducted since 1987 consistently show that individuals with schizophrenia show deficits in emotion recognition compared with nonclinical controls with large effect sizes for chronic patients.[58,90] Though earlier studies showed that schizophrenia patients had more difficulty identifying negative (eg, fear) than positive (eg, happiness) emotions,[91,92] more recent findings have failed to support these claims.[13,89] The recognition deficit is present early in the course of the illness,[35,93] may precede its onset (Addington et al[94] but see Pinkham[35] for contradictory findings), and may be stable across clinical episodes.[95,96] Some studies do suggest that remitted individuals may perform better than individuals in an acute phase.[97] Although emotion recognition has shown an inconsistent relationship to positive or negative symptoms,[90,98,99] consistent associations with community functioning have been observed.[100]

To the extent that context processing is essential for performance on the face + context portions of this task and that context-processing deficits are commonly observed in schizophrenia,[101] one might expect performance on face + context trials to be impact by schizophrenia. This paradigm was recommended for further development as a complement and extension of the ER-40. Because the lower level construct has been well established as a target while also offering a potential window onto the interactions of top-down and more basic aspects of emotional responding in schizophrenia, future studies will need to characterize performance on this task in schizophrenia, optimize parameters for efficient measurement and measures, and optimize psychometric properties. Hence while highly promising the task needs much more extensive development than the ER-40. With regard to the generalized deficit problem, this task has potential promise. In the presence of a context-processing deficit when the context and the face are incongruent, emotion identification performance may be actually be relatively more accurate in patients compared with healthy subjects, providing evidence for a differential deficit via the "process dissociation" approach.[102]

In summary, 2 tasks measuring aspects of emotion identification and responding were recommended for further development by the participants of the third CNTRICS meeting. In the future, additional basic research as well as the systematic investigation of other elements of the social and emotional processing stream promises an even more detailed understanding of the emotional and social deficits affecting people with schizophrenia. It is anticipated that along with this progress additional measures will be identified and developed that will further enhance our ability to target for treatment development of these important functional deficits in schizophrenia.

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