CHAPTER EIGHT

Social Cognition in Intermittent Explosive Disorder

Emil F. Coccaro, Kristin A. Ridder
Clinical Neuroscience & Psychopharmacology Research Unit, Department of Psychiatry and Behavioral Neuroscience, Pritzker School of Medicine, University of Chicago, Chicago, IL, United States

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Introduction

There is no question that human aggressive behavior is under both genetic and environmental influence. In fact, twin studies conducted by our group, as well as and other groups, have shown that no less than 50% of the variance in aggression scores are due to nongenetic, "environmental," factors (also see the chapter on Behavioral/Molecular Genetics, this volume). Such variance is due to shared (common to both twins) and nonshared (unique to each twin) environmental factors as well as measurement error. Shared and nonshared factors include parenting behavior/exposure to violence, exposure to physical and sexual trauma, as well as exposure to potentially addictive psychopharmacologic agents, among others. The relationship between aggression and some of these factors is discussed in greater detail in other chapters in this volume. In this chapter, we will discuss the influence of parenting behavior and exposure to violence as it relates to their impact on social-emotional information processing (SEIP) also referred to as social cognition.

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Social-Emotional Information Processing

Early work in developmental psychology by Bandura (1973) suggested that cognitive learning processes are important in the transmission of aggression from parent to child. The now famous Bobo doll experiment, in which children are shown how to be aggressive toward a proxy object by a parental figure, demonstrated that children learn behavior by imitating, or modeling, someone else's behavior so that children learn to be aggressive by observing aggression in their families and in the community (Bandura, 1973).

Later studies, also, demonstrated that maltreatment during childhood has negative effects on a number of cognitive functions (Irigara et al., 2013) including deficits in verbal and episodic memory, working memory, attention, and executive functions. Childhood maltreatment has also been shown to adversely impact social-emotional development in adolescence and adulthood and is associated with negative cognitive schemas regarding self and others, deficits in affect regulation, conditioned associations between abuse stimuli, emotional distress, and memories/cognitions of maltreatment triggered by environmental stimuli. In addition, childhood maltreatment has been associated with social information processing problems, including reductions in encoding relevant social cues, increased hostile attribution bias, as well as a general tendency to select, and value, aggressive responses to hypothetical socially ambiguous interactions (Weiss, Dodge, Bates, & Pettit, 1992).

Research regarding the development and maintenance of aggression highlights a variety of social cognitive processes and has shown that aggressive individuals are more likely than others to interpret both ambiguous and benign cues as hostile, and that hostile attribution biases are positively related to aggressive behavior (Dodge, 1980; Teisl & Cicchetti, 2008). Importantly, a meta-analysis of more than forty studies reports robust and significant associations between a hostile attribution of intent and aggressive behavior (de Castro, Veerman, Koops, Bosch, & Monshouwer, 2002). Based on this work, Dodge, Bates, and Pettit (1990) proposed a social information processing theory to explain 'the cycle of violence' described by previous investigators. This group suggested that abused children are more likely to develop deficient patterns of social information processing, which result in increased levels of aggression. This theory (Crick & Dodge, 1994; Dodge, 1986) described six steps of SIP: (1) encoding (i.e., selective attention to internal and environmental cues such as facial cues and verbalizations), (2) interpretation and mental

representation of these cues (e.g. attributions of intent, a function of attention to particular cues), (3) clarification of goals (i.e., selecting desired goals and outcome of the situation), (4) response access or construction (i.e., generation of possible responses), (5) response evaluation and decision (i.e., determination of the quality of each alternative response and evaluation of the likelihood that each alternative will produce the desired outcomes), and (6) behavioral enactment (i.e., behavioral response; Crick & Dodge, 1994). Deficits in social information processing have been shown to partially mediate the effects of early life maltreatment on later aggressive behavior across the lifespan (e.g. Calvete & Orue, 2011; Dodge et al., 1990; Dodge, Pettit, Bates, & Valente, 1995; Taft, Schumm, Marshall, Panuzio, & Holtzworth-Munroe, 2008). In prospective studies, Weiss et al. (1992) have demonstrated that harsh discipline significantly predicted child aggression six months later, even after controlling for socioeconomic status, child temperament, and marital violence. The results showed that harsh parental discipline predicted later school aggression that was partially mediated by impairments in social information processing. In another longitudinal study, Dodge et al. (1995) reported that one-third of the variance (33%) in the relationship between aggression exposure in childhood and later behavioral problems was accounted for by attention to and encoding of relevant social cues, hostile interpretations of peers' intentions, accessing of aggressive behavioral responses to cues, and favorable evaluation of the consequences and desirability of aggressive responses

In addition to social cognitive factors, other work has pointed to the relevance of emotional regulation in the development of aggression especially in the context of the relationship between childhood maltreatment and later aggressive behavior. For example, Briere (2002) proposes that normal emotion regulation develops through the process of trial-and-error learning to manage uncomfortable internal states and that children progressively develop increasingly sophisticated strategies of internal coping as they encounter more challenging and stressful experiences. If so, it is extremely difficult for children exposed to violence at the hands of their caretakers to develop these adaptive skills because ongoing aggression toward the child disrupts their trial-and-error learning leading to affective instability, difficulty in inhibiting expression of strong negative affect, and difficulty in limiting their dysphoric state. Such individuals tend to be emotionally hyper-responsive and overreact to negative/stressful events due to their inability to effectively regulate their emotions and this results in aggression and related behaviors such as substance abuse, inappropriate sexual behavior, bingeing/purging, or self-injury (Briere & Gil, 1998). Supporting this view

is data showing a positive relationship between a history of child abuse and emotion dysregulation (Cloitre, Stovall-McClough, Zorbas, & Charuvastra, 2008; Kim & Cicchetti, 2010).

While the literature tends to separate cognitive and emotional factors in this regard, it is likely that both are involved in the development and maintenance of aggression. Lemerise and Arsenio (2000) first proposed to include emotion processes in social information processing models in order to expand the explanatory power of these models to understand aggressive behavior. In their review of the interdependence of cognition and emotion, Storbeck and Clore (2007) posit that emotion processes modulate and mediate basic cognitive processes. Others (Teisl & Cicchetti, 2008) have demonstrated that maladaptive cognitive and emotional processes made unique contributions to the relationship between child physical abuse and peer nominations of aggression and disruptive behavior in a sample of children aged 6 to 12. In their study scores of social information processing accounted uniquely for 10% of the variance in the overall indirect effect, while scores of emotion regulation accounted uniquely for 55% of the variance in the indirect relationship between child abuse and aggression. Thus each factor contributed unique variance to the relationship between child abuse and aggression. Others suggest that social cognitive and emotional processes interact with one another (Lee & Hoaken, 2007). In fact, neural mechanisms that underlie social and emotional processes may be partly redundant and interactive and results of fMRI studies reveal interactions between regions of the brain thought to be involved in the processing of these types of information (Norris, Chen, Zhu, Small, & Cacioppo, 2004). The authors employed fMRI to examine brain activity while participants viewed pictures that included emotional or social content. They suggested that regions of the brain previously implicated in social and/or emotional processes showed evidence of an interaction in processing. Evidence for such an interaction in social and emotional processing was provided by patterns of brain activation in the superior temporal sulcus, the middle occipito-temporal cortex, and the thalamus. These regions of the brain that have been implicated in processing social information appeared especially active when the stimuli also conveyed emotional information (Fig. 2).

Social-Emotional Information Processing in IED

Similar studies in IED had to wait until SEIP research protocols were developed for use in adults as opposed to children and young adolescents.

We published our first work in this area, late in the last decade, with a six-item assessment of attribution and emotional response (Coccaro, Noblett, & McCloskey, 2009). This assessment began as a 10 vignette questionnaire that briefly described socially ambiguous interactions reflecting five physically aggressive and five relationally aggressive scenarios. Our assessment was developed in three phases in a group of population-based individuals. In the first phase we determined the optimal format of the assessment and settled on eight vignettes (four from each type) and reported on its psychometric properties. The second phase replicated these findings in separate, but similar, group of individuals while the third phase examined the assessment's properties in a third group of research participants with and without IED.

Among the six SEIP assessment questions following each vignette were four assessing attribution and two assessing negative emotional response. Two questions in the former set asked about hostile attribution (HA) and one each asked about instrumental attribution (IA) and benign attribution (BA). The two HA questions asked to what extent the intent of the "other's" action in the vignette was designed to hurt the person directly or hurt the person's status/reputation. The IA question asked to what extent the intent of the "other's" action in the vignette was designed to enable the "other" to reach his/her objective while the BA question asked to what extent the "other's" action was accidental in intent. The two negative emotional response (NER) questions asked the subject how angry, and how upset and/or embarrassed, they would be if the "other" in the vignette had acted that way with them. Analyses of these data confirmed that each form of attribution was a valid reliable variable and that the same was true for the negative emotional response variable. Across community subjects, HA but not IA, correlated directly with measures of aggression and hostile automatic thoughts while BA correlated inversely with these variables. In turn, HA displayed a strong positive relationship with NER while IA showed little correlation and BA showed an inverse correlation with NER confirming the idea that HA, but not IA, is associated with anger and that BA is associated with a dampening of anger. This supports the strategy of assisting angry individuals to reframe their social cognition so that they see aversive behavior as not personal to them (i.e., "instrumental" behavior on the part of the other, or accidental in nature). Analysis of the non-population-based study participants demonstrated that those with IED had significant higher HA and NER, and lower BA, scores compared with those of healthy controls confirming that elevated HA and NER scores are important features of IED.

Our second study (Coccaro, Fanning, Fisher, Couture, & Lee, 2017; Coccaro, Fanning, & Lee, 2017) extended this work by also including an assessment of response, evaluation, and decision (RED) making in the context of social threat (Coccaro, Fanning, Keedy, & Lee, 2016). In addition, this study replicated the nature of the psychometric properties of the attribution and negative emotional response variables and reported, further, that SEIP vignettes with relationally aggressive scenarios evoked higher HA and NER scores compared with vignettes with physically aggressive scenarios. The latter observation suggests that social threat directed at one's place in their social world is associated with a greater SEIP response than social threat limited to physical assault/injury.

RED variables were assessed in response to three different kinds of possible responses to the social threat described in the SEIP vignettes: socially appropriate responses, directly aggressive responses, and relationally aggressive responses. For each possible response, participants were asked how likely, or how favorably, they viewed each possible response in terms of: (a) how good is it to act this way ("response valuation"); (b) if you acted this way, how would you feel about yourself, how likely is it that you would get what you want, that others will like you, that others would respect you ("outcome expectation"); (c) how easy would it be to act this way ("response efficacy") and, how likely is it that you would act this way ("response enactment"). Each individual RED variable demonstrated good psychometric properties in terms of reliability and construct validity. In addition, each RED variable for socially appropriate, and for each aggressive, response interacted as expected. That is, RED variable scores for both socially appropriate responses (Mean $\pm$ SD: $r = 0.61 \pm 0.14$), and for both aggressive responses (Mean $\pm$ SD: $r = 0.73 \pm 0.06$) were highly intercorrelated but not with regard to contrasting types of responses (i.e., socially appropriate with aggressive responses; Mean $\pm$ SD: $r = -0.03 \pm 0.11$).

In addition, for socially acceptable responses Total RED scores displayed inverse, though nonsignificant, correlations with HA ($r = -0.21$) and NER (-0.02) scores, displaying positive and statistically significant correlations, instead, with IA ($r = 0.41$) and BA ($r = 0.30$) scores. In comparison, Total RED scores for aggressive responses revealed moderately strong positive correlations with HA ($r = 0.50$); NER also correlated with Total RED scores ($r = 0.40$) while BA was inversely, and statistically significantly, correlated with the Total RED scores ($r = -0.31$) and IA was uncorrelated ($r = -0.09$). These observations suggest that the more an individual's view of another person's agonistic behavior is instrumental or benign, the more

likely they are to value a socially acceptable response to potential social threat. In contrast, the more likely an individual's view of the other's behavior is hostile the more likely they are to value an aggressive response to potential social threat.

In the clinical research sample reported in the study, Total RED scores for socially appropriate responses were significantly lower among IED compared with healthy control subjects but significantly higher among IED compared with those among healthy control subjects in keeping with the idea that impulsively aggressive individuals view aggressive responding to ambiguous social threat positively. That said, it is important to note that, even among those with IED, socially acceptable responses to social threat are viewed, overall, more favorably than aggressive responses (i.e., RED scores of 1.76 ± 0.03 for socially appropriate responses *vs.* 1.07 ± 0.04 for aggressive responses, $P < .001$) indicating that the key observation is that those with IED are more likely to favor aggressive responses than are healthy, or psychiatric, controls.

Our third study (Coccaro et al., 2016) included a larger, nonoverlapping, sample of individuals with IED ($n = 100$) as well as healthy ($n = 100$), and nonaggressive psychiatric ($n = 100$), controls. Inclusion of the latter group allowed for a control of general psychopathology in the IED group. In this study, those with IED were found to have higher HA, NER, and Total RED scores compared with both healthy and psychiatric controls. Since inclusion of nonaggressive psychiatric subjects controls for the general psychopathology present in IED, and others with a nonaggressive psychiatric disorder, these findings show that aberrant SEIP is associated with impulsive aggression rather than to other aspects of psychopathology (Fig. 1).

Most importantly, this study included a detailed analysis of which aspects of SEIP correlated with history of actual aggressive events using the Life History of Aggression assessment. Placing all SEIP variables into the same statistical model revealed that the unique correlates of actual aggressive behavior were the NER ($\beta = 0.31$, $P < .001$) and Total RED ($\beta = 0.32$, $P < .001$), but not the HA ($\beta = -0.07$, $P = .342$), variable scores suggesting that negative emotional responses (NER) to ambiguous agonistic interactions and the positive view of behaving in an aggressive manner (RED) may be more critical to the display of aggressive behavior in social agonistic interactions than HA, which up until now has been thought to be the key variable in SEIP.

Our next effort was to put the SEIP stimuli into video form and to create a computer-based Video-SEIP assessment (V-SEIP; Coccaro et al., 2016) that enables the assessment of "encoding" which cannot be done with a

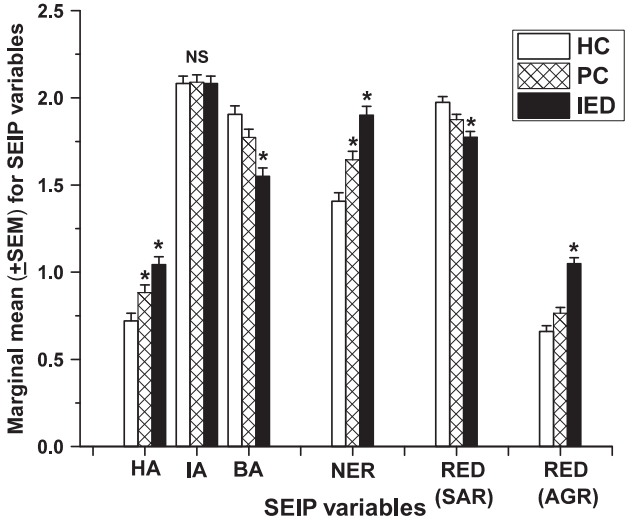

Fig. 1 Marginal means (±SEM) after ANCOVA for SEIP attributional, emotional, and response and evaluation variables in healthy (HC) and psychiatric (PC) controls and in those with IED.

paper-and-pencil assessment. For our V-SEIP assessment we produced short (e.g., 10 s) video clips of each vignette along with short video clips illustrating socially appropriate, directly aggressive, and relationally aggressive responses. After viewing the vignette video clip, study participants were asked to recall and record all the relevant elements shown in the video clip ("encoding"; ENC). These recalled elements were scored by behavioral raters as "relevant" or "irrelevant" to the main action in the video clip according to an *a priori* list of elements. IED study participants identified fewer relevant vignette elements compared with both healthy and psychiatric control study participants. This study also replicated the findings reported in the previous papers regarding HA, NER, and RED variables (Fig. 2). Most importantly, simultaneous analysis of all SEIP variables revealed that ENC, NER, and Total RED, but not HA, scores uniquely correlated with history of aggressive behavior. ENC scores correlated inversely, while NER and RED scores correlated positively with life history of aggression. The standardized beta coefficients were similar for ENC (-0.17, $P<.05$) and NER ($+0.18$, $P<.05$), but substantially greater for the Total RED ($+0.54$, $P<.001$), scores supporting the role of these three SEIP variables, especially RED, in aggression and IED. Given the NER results in the previous study ($\beta=0.31$, $P<.001$), it appears that the variance related to NER in this study may be split between NER and ENC.

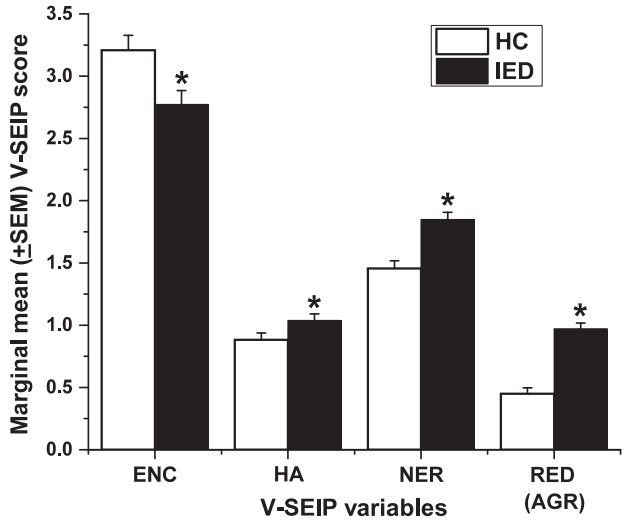

Fig. 2 Marginal means (±SEM) after ANCOVA for Video-SEIP scores for encoding, hostile attribution, negative emotional response, and response and evaluation variables in healthy controls (HC) and those with IED.

When we expose healthy human subjects to these SEIP videos (both aggressive and nonaggressive in nature) in the fMRI scanning environment we find that the stages of ENC, HA, and NER have differential activations in cortico-limbic circuits. As part of an ongoing study, we have found that individuals with IED have reduced activity, compared with healthy controls, when viewing both aggressive and neutral SEIP videos during these three SEIP phases: (a) reduced activation in the medial prefrontal cortex and anterior cingulate cortex during encoding, (b) reduced activation in the dorsolateral prefrontal cortex and temporoparietal junction during attribution, and (c) reduced activation in the superior prefrontal cortex and periaqueductal gray during negative emotional response. This strongly suggests that deficits in SEIP have relevant correlates in cortico-limbic circuit functioning and does not simply represent a psychological construct.

These findings are important for work designed to improve aberrant SEIP in impulsively aggressive individuals. If variables related to ENC, NER, and RED variables are critical to aggressive responding, then potential interventions should focus on strategies that can improve attention to relevant stimuli, reduce angry reactions to agonistic social threat, and reduce the favorable view of aggressive responses in those with impulsive aggression. Cognitive-behavioral interventions for IED (McCloskey, Noblett, Deffenbacher, Gollan, & Coccaro, 2008; also see Chapter on Psychological

Interventions) include cognitive restructuring which aims to reduce hostile automatic thoughts (and presumably HA) by assisting the patient to understand that what they experience as social threat is, in fact, something benign. In addition, cognitive-behavioral interventions also include coping skills training whereby the patient reexperiences situations that trigger their anger, under the therapist's supervision and guidance, so that they can employ different responses to threat and reduce reactive anger. While training to reduce the favorability of aggressive responses to social threat is not formally included in this type of intervention, it often comes up during the treatment.

At this time, there is no formal clinical treatment program that employs interventions designed to modify SEIP variables. However, recent work has been published that suggests that interventions that reduce HA can reduce aggressive behavior in children and adolescents. One set of studies developed a computer task that trains individuals to view mixed, morphed, angry-happy faces as more happy than angry (Penton-Voak et al., 2013). In this study of healthy volunteers the investigators reported a significant reduction in the amygdala response to angry faces after such training. In another study, such training was reported to reduce actual aggressive behavior in adolescents with conduct disorder as rated by both adolescent and staff (Stoddard et al., 2016). While these individuals were not diagnosed as IED, some would likely meet criteria IED. The observation that reducing hostile attribution can have an antiaggressive effect is not inconsistent with the data reported before which suggests that HA is not uniquely related to aggression. This is because HA is related to aggression, by itself, but that other facets of SEIP, when added, better account for the relationship between SEIP and aggression. This is especially true when one first adds NER to the model. This raises the possibility that designing interventions that focus on improving encoding, reduce anger proneness, and reduce the mind-set that aggressive responses to social threat are "appropriate" given the situation, maybe more effective than simply reducing hostile attribution bias.

Conclusion

SEIP represents a critical set of processes under the rubric of social cognition. It has been shown to be related to aggression, especially impulsive aggression, and undoubtedly places an important role in the proximal factors that lead to impulsive aggressive behavior. SEIP can be assessed in human subjects fairly easily from both a psychometric and neuropsychobiological point of view. It is likely that clinical/therapeutic strategies that work to reduce aberrant SEIP will be important in treating impulsive aggressive individuals with deficits in SEIP.

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