



## Smoking history, and not depression, is related to deficits in detection of happy and sad faces



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### HIGHLIGHTS

- Impact of smoking history and depression on cognitive functions.
- History of smoking was associated with reduced emotion perception accuracy.
- Depression was associated with poorer executive functioning performance.
- No additive decrements in those with a history of smoking and depression observed.

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### ABSTRACT

**Introduction:** Previous research has demonstrated that chronic cigarette smoking and major depressive disorder (MDD) are each associated with cognitive decrements. Further, these conditions co-occur commonly, though mechanisms in the comorbid condition are poorly understood. There may be distinct, additive, or overlapping factors underlying comorbid cigarette smoking and MDD. The present study investigated the impact of smoking and MDD on executive function and emotion processing.

**Methods:** Participants (N = 198) were grouped by diagnostic category (MDD and healthy controls, HC) and smoking status (ever-smokers, ES and never-smokers, NS). Participants completed the Facial Emotion Perception Test (FEPT), a measure of emotional processing, and the parametric Go/No-go task (PGNG), a measure of executive function.

**Results:** FEPT performance was analyzed using ANCOVA with accuracy and reaction time as separate dependent variables. Repeated measures MANCOVA was conducted for PGNG with performance measure and task level as dependent variables. Analyses for each task included diagnostic and smoking group as independent variables, and gender was controlled for. Results for FEPT reveal that lower overall accuracy was found for ES relative to NS, though MDD did not differ from HC. Post-hoc analyses revealed that ES were poorer at identifying happy and sad, but not fearful or angry, faces. For PGNG, poorer performance was observed in MDD relative to HC in response time to Go targets, but there were no differences for ES and NS. Interaction of diagnosis and smoking group was not observed for performance on either task.

**Conclusions:** The results of this study provide preliminary evidence for distinctive cognitive decrements in smokers and individuals with depression.

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### 1. Introduction

Chronic cigarette smoking is linked to several adverse health outcomes, including cerebrovascular disease, cardiovascular disease,

respiratory disease, cancer and major depressive disorder (MDD). Such diseases accounted for two-thirds of deaths worldwide between the years 1990 and 2010 (Lozano et al., 2012). Previous research suggests that annual rates of morbidity and mortality are greater for cigarette smokers compared to nonsmokers (McGinnis & Foege, 1993), as well as for individuals with MDD compared to those without MDD (Wuslin, Vaillant, & Wells, 1999). Further, rates of smoking are higher among individuals with MDD (Dierker, Avenevoli, Stolar, &

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Merikangas, 2002; Langenecker, Finkenauer, et al., 2009; Langenecker, Lee, & Bieliauskas, 2009). Troscclair and Dube (2010) found that 33% of individuals with lifetime history of depression or anxiety were current smokers. Likewise, 22% of individuals without psychiatric illness have a history of smoking (Pratt & Brody, 2010). Also, depressive symptoms are heightened during smoking cessation attempts, and may interfere with smoking cessation attempts (Covey, Glassman, & Stetner, 1990; Glassman et al., 1990; Langenecker, Finkenauer, et al., 2009; Langenecker, Lee, & Bieliauskas, 2009; Tsoh & Sharon, 2004). Despite the substantial overlap of cigarette smoking and MDD, the co-occurrence of these conditions remains understudied.

Prior explorations have implicated genetics, negative affectivity, attentional dysfunction, and disrupted nicotinic function as overlapping, distinct, and additive factors in comorbid MDD and smoking (Gilbert & Gilbert, 1995; Grant, Hasin, Chou, Stinson, & Dawson, 2004; Spada, Nikcevic, Moneta, & Wells, 2007; Tsuang, Francis, Minor, Thomas, & Stone, 2012). Further, both smoking (Carmody, Vieten, & Astin, 2007; Durazzo, Meyerhoff, & Nixon, 2010; Gilbert & Gilbert, 1995) and MDD (Bourke, Douglas, & Porter, 2010; Iverson, Brooks, Langenecker, & Young, 2011; Langenecker et al., 2005) have independently been associated with affective and cognitive impairments known to detrimentally impact functioning in a variety of settings. For instance, emotion perception, the ability to identify and respond to facial expressions of emotion, is critical for successful social interactions. Difficulties with emotion perception can result in interpersonal communication problems that can impair an individual's social and vocational practices (Bourke et al., 2010; Carton, Kessler, & Pape, 1999; Langenecker et al., 2005). Likewise, deficits in executive functions, which include abilities to plan, make decisions, attend to stimuli, and inhibit inappropriate responses, may hinder one's ability to function optimally. Ultimately, emotion processing and executive function decrements may interfere with recovery from depressive episodes (Porter, Bourke, & Gallagher, 2007) or an individual's ability to quit smoking (Carmody et al., 2007; Mendrek et al., 2006). In MDD, executive dysfunction is associated with poor treatment response to standard depression treatments (Kampf-Sherf et al., 2004). Thus, obtaining critical information about the impact of smoking on executive functions and emotional processing among individuals with and without MDD may inform clinical care by guiding existing interventions for these conditions, while also directing the development of novel treatments. For example, if executive functioning deficits confer risk for smoking and MDD together, but not MDD alone, then treatment decisions that target executive functioning may be ineffective in MDD alone.

Despite the advantages of exploring affective and executive functions in comorbid MDD and cigarette smoking, there is little research on the topic. Typically, smoking precludes participation in neuropsychological studies of MDD, and MDD is often an exclusionary, uncontrolled, or self-report variable in studies of smoking. While exclusion as a methodology serves to elucidate the specific associations of each condition with cognition independently, the findings from these studies may have limited ecological utility given high rates of comorbidity. Comorbid MD and smoking may have shared risk factors, such as disruption of executive functions and emotion perception.

Executive impairments are among the most common cognitive symptoms associated with both MDD (Porter et al., 2007; Rogers et al., 2004) and cigarette smoking (Jacobsen et al., 2005; Mendrek et al., 2006; Swan & Lessov-Schlaggar, 2007). Impairments in attention and executive functioning appear to persist following the remission of depressive episodes and are thought to represent trait characteristics or risk factors for depression (Langenecker, Lee, & Bieliauskas, 2009; Paelecke-Habermann, Pohl, & Leplow, 2005). It is less clear, however, whether executive dysfunction continues after individuals have quit smoking. Existing studies of executive functions in temporarily abstinent smokers reveal behavioral decrements similar to those observed in MDD, yet this does not address the long-term effects of smoking (Swan & Lessov-Schlaggar, 2007). Among chronic smokers, cognitive

decrements include reduced psychomotor speed, cognitive flexibility, and visual search speed (Durazzo et al., 2010; Kalmijn, van Boxtel, Verschuren, Jolles, & Launer, 2002; Richards, Jarvis, Thompson, & Wadsworth, 2003), though reports are inconsistent as samples and methodology vary greatly across studies. Findings on executive functions in former smokers relative to never smokers are also mixed, although one study did report that those who were able to quit had better executive functioning (Ernst, Heishman, Spurgeon, & London, 2001).

MDD often presents with emotional processing impairments (Gollan, McCloskey, Hoxha, & Coccaro, 2010; Versace et al., 2010). For smoking, research suggests that negative affect is a motivation for smoking in a larger percentage of smokers (Kassel, Stroud, & Paronis, 2003). Cognitive theories of psychiatric conditions such as depression propose that biases in judgment of emotional processes are disease-related. When such biases occur, individuals misinterpret situations and may respond in a maladaptive manner, which further exacerbates their conditions (Kahler et al., 2012). MDD has been associated with impaired recognition of facial expressions (Bourke et al., 2010; Kohler, Hoffman, Eastman, Healey, & Moberg, 2011; Wright et al., 2009). It has been suggested that some of these impairments in emotion perception resolve during remission and that increased bias of judging ambiguous faces as negative facial emotions may be predictive of persistent depression at later time points (Bouhuys, Geerts, & Gordijn, 1999; Hale, 1998). In smoking, it is unclear whether the pattern of poor emotion identification observed for MDD is also present in smokers.

As a means of addressing limitations in the literature, the present study will examine shared mechanisms and impact of MDD and smoking upon emotion perception and executive functioning. It was expected that individuals with MDD and a history of cigarette smoking would perform worse than non-depressed, non-smoking controls on tests of executive function, examining attention and inhibitory control, and emotion identification. Exploratory analyses addressed the impact of comorbid smoking and MDD on measures of executive functioning and emotion identification.

## 2. Method

### 2.1. Participants

This was a retrospective study of 194 participants (78 healthy controls, HC, and 116 MDD). Depressed participants completed smoking and cognitive measures as part of a standard intake battery prior to their first psychiatric assessment for depression at the University of Michigan Depression Center. HCs were recruited through projects at the University of Michigan as part of a larger sample reported elsewhere (Langenecker et al., 2007). Absence of psychiatric conditions in HC was confirmed for 13 participants using the Structured Clinical Interview for DSM-IV (SCID-IV; First, Spitzer, Gibbon, & Williams, 1995) non-patient version and for 65 participants using the Diagnostic Interview for Genetic Studies (DIGS; Nurnberger et al., 1994). Key demographic and clinical variables relevant to diagnosis group and smoking status are reported in Table 1.

#### 2.1.1. Participant characteristics

MDD participants were diagnosed via clinical interview by board-certified psychiatrists ( $n = 93$ ), with the SCID-IV patient version ( $n = 15$ ), or with the DIGS ( $n = 8$ ). Among MDD, most participants met criteria for diagnosis of MDD alone (71%) or MDD comorbid with an anxiety disorder (12%). The remaining MDD subjects had a diagnosis within the broader spectrum of mood disorders (e.g., mood disorder NOS (9%), dysthymia (0.2%) or no DSM-IV diagnosis (7.8%, yet with significant depression symptoms)). There were 64% of MDD who were currently taking psychotropic medications (mean number of medications = 1.39,  $SD = 1.49$ ). No HC participants met criteria for any psychiatric disorder (current or past). Among MDD and HC, there

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