



Reduced emotional and cardiovascular reactivity to emotionally evocative stimuli in major depressive disorder



Alvin B. Jin^a, Lindsey H. Steding^b, Andrea K. Webb^{a,*}

^a The Charles Stark Draper Laboratory, 555 Technology Square, Cambridge, MA 02139, USA

^b University of South Florida, 4202 E Fowler Ave., PCD 4118G, Tampa, FL 33620, USA

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ABSTRACT

Major Depressive Disorder (MDD) is a highly debilitating mental health concern that affects a large number of adults in the United States. The emotional context insensitivity (ECI) hypothesis argues that individuals with MDD disengage from the environment to defend themselves from futile activity. In the current study, electrocardiogram and pupillometry were recorded from 50 participants (MDD $n = 25$, never depressed control $n = 25$) during the display of emotionally evocative images, sounds, and movie clips. Individuals with MDD reported reduced change in happiness to positively- and negatively-valenced images and sounds. Heart rate reactivity also was reduced in individuals with MDD when viewing images and watching movie clips. These results suggest that individuals with MDD may have some difficulty engaging with certain environmental stimuli.

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1. Introduction

Major Depressive Disorder (MDD) is a highly debilitating mental health concern that affects at least 16% of the U.S. adult population at some point in their life (Kessler et al., 2005). The emotional context insensitivity (ECI) hypothesis was developed from attempts to explain the impairments of depression from an evolutionary perspective, and argues that individuals with MDD disengage from the environment in an attempt to defend themselves from futile/dangerous activity (Rottenberg and Gotlib, 2004; Rottenberg et al., 2005a; Schneider et al., 2012). As a result, individuals with MDD may be characterized as being less emotionally reactive to environmental stimuli. The ECI hypothesis may be tested by evaluating both subjective responses and autonomic reactivity while experiencing a wide variety of emotional stimuli.

Passive viewing tasks are often used to test the ECI hypothesis in individuals with MDD. During both positively-valenced movie clips (Kaviani et al., 2004) and images (Sloan et al., 1997, 2001), individuals with MDD report a reduced change in valence. Reductions in responses are also seen in specific emotions; individuals with MDD react with reduced happiness to happy movies (Rottenberg et al., 2005a) and images (Dunn et al., 2004). Similarly, during negatively-valenced movies, individuals with MDD rate movies with reduced changes in valence (Kaviani et al., 2004) and sadness (Rottenberg et al., 2005a). Responses to negatively-valenced images do not follow the same pattern; no

differences are found between individuals with MDD and control individuals (Sloan et al., 1997, 2001; Dunn et al., 2004). The ECI hypothesis is not the only view of emotional reactivity. Positive attenuation states that individuals with MDD primarily have reduced reactivity to positive emotional stimuli. The subjective ratings of emotional experience during movies supports the ECI hypothesis, but previous ratings of images do not clearly support either the ECI hypothesis or positive attenuation. Further evaluation of subjective emotional ratings of brief positively- and negatively-valenced images can provide additional information about emotional responding in individuals with MDD. Other measures may be collected in conjunction with self-reported ratings to provide stronger support for the ECI hypothesis.

Cardiovascular reactivity has been used to evaluate the ECI hypothesis during both passive viewing tasks, such as viewing movies as previously noted, as well as more active tasks. Reduced reactivity is often observed during active tasks; individuals with MDD have reduced heart rate (HR) reactivity when giving a speech, completing a mirror tracing task (Salomon et al., 2009), and doing mental arithmetic (Phillips, 2011). Respiratory sinus arrhythmia (RSA) withdrawal during speech and mirror tracing tasks is also reduced in individuals with MDD compared to control individuals (Rottenberg et al., 2007a). However, during passive viewing of movies, individuals with MDD do not differ from control individuals on HR or RSA reactivity (Rottenberg et al., 2002, 2005b). Despite the lack of differences between groups in physiological reactivity, examining cardiovascular patterns within those with MDD reveals some important findings. Individuals with MDD who had greater HR reactivity to an amusing movie were more likely to be in remission six months later (Rottenberg et al., 2002), and individuals with

* Corresponding author at: 555 Technology Square, Cambridge, MA 02139, USA. Tel.: +1 617 258 4131; fax: +1 617 258 3711.

E-mail address: awebb@draper.com (A.K. Webb).

MDD who had the greatest RSA reactivity during a sad movie clip were also more likely to be in remission six months later (Rottenberg et al., 2005b). Although no group differences between individuals with MDD and control individuals were found in HR or RSA, the relationship between greater reactivity and likelihood of remission suggests that cardiovascular reactivity during passive viewing tasks may be affected in individuals with MDD.

Stimulus stereotypy (Lacey and Lacey, 1958) may help explain why HR differences between individuals with MDD and control individuals are found in active tasks but not passive tasks. Generally stimuli that have components of sensory rejection, such as active stress tasks, are associated with increases in HR, while stimuli that are related to sensory intake, passive viewing tasks, are related to decreases in HR (Lacey et al., 1963). During active tasks like speaking and mental arithmetic, individuals with MDD who are not engaging in the tasks do not need to reject the extraneous stimuli from the environment, resulting in smaller increases in HR. Individuals with MDD may not have reduced reactivity to movies because there are a wide variety of stimuli present within the movies (i.e., visual, audio, and content changes). Brief images and sounds may be better at detecting cardiovascular differences of engagement with passive stimuli by focusing on a single sensory domain. HR during both standardized images (Lang et al., 1993) and sounds (Bradley and Lang, 2000) initially decelerates and then returns to resting, which results in an overall deceleration over a 6-second period of presentation. Standardized sounds produce similar changes in HR as images; however, no previous findings have reported how individuals with MDD differ from control individuals in both subjective responses and cardiovascular reactivity to standardized sounds. Cardiovascular differences between individuals with MDD and control individuals due to engagement with a stimulus may be easier to detect using stimuli such as standardized images and sounds compared to the previously used movie clips.

Cardiovascular reactivity may not be the only useful physiological variable for identifying differences in engagement with passive viewing tasks. Pupil diameter reactivity has been proposed as a potential index of attentional processes (e.g., Beatty and Lucero-Wagoner, 2000), because of greater pupil diameter during selective attention and vigilance tasks. Attentional processes may contribute to pupil diameter increases to both positively- and negatively-valenced images (Bradley et al., 2008) and sounds (Partala and Surakka, 2003) compared to corresponding neutral stimuli. Participants may be attending to the positively- and negatively-valenced stimuli more than the neutral. Individuals with MDD and control individuals have not been directly compared on pupil diameter reactivity during images and sounds, but studies have examined differences for pupil reactivity to emotional words. Reduced pupil diameter reactivity during negatively-valenced emotional words was related to a greater chance of remission after cognitive therapy (Siegle et al., 2011). This is in contrast to effects seen for cardiovascular reactivity; reduced cardiovascular reactivity was related to a smaller likelihood of remission (Rottenberg et al., 2002, 2005b). The relationship between lower chance of remission and greater pupil diameter reactivity to negatively-valenced words also may point to a different model of emotional reactivity, negative potentiation. Negative potentiation posits that negative mood in individuals with MDD enhances these individuals' emotional reactivity to specifically negative emotional stimuli. Individuals less likely to recover may be thinking more about the negative words compared to individuals who are able to separate and avoid thoughts about those words. However, viewing words may not be the same as viewing brief images or sounds. During images and sounds, a participant is presented with the emotional content of the stimulus as opposed to word presentation when the participant may be evaluating how the word relates individually. Emotional words may elicit specific ruminative processes that are unique from passive viewing tasks. Pupil diameter reactivity during image and sound presentation could provide complementary information to use with subjective responses and cardiovascular reactivity.

The ECI hypothesis suggests that individuals with MDD are disengaging from the environment in an attempt to avoid futile/

dangerous activities. During passive viewing tasks, the ECI hypothesis has only mixed support. Positive images are often rated subjectively as not eliciting as much emotion in individuals with MDD compared to control participants, but ratings of negative images do not differ. Additionally, differences in cardiovascular reactivity between individuals with MDD and control individuals are generally not observed in passive viewing tasks like movies. Finally, pupil diameter in individuals with MDD has not been well evaluated using passive viewing tasks.

The current study attempts to provide an additional test of the ECI hypothesis by further evaluating subjective and autonomic reactivity differences between individuals with MDD and control individuals. Specifically, adding subjective responses and autonomic reactivity during standardized sounds allows another modality to compare with reactivity during emotionally evocative images and movies. Both the images and sounds may better identify differences in cardiovascular reactivity due to the limited sensory information compared to movies. Examining pupil diameter during these passive tasks also may provide additional information about how individuals with MDD engage with emotional stimuli differently than control individuals. Individuals with MDD should respond to these additional aspects with reduced subjective emotional responses and reduced cardiovascular and pupil reactivity. We also will explore the changes in state anxiety and state negative affect experienced from pre- to post-protocol time points as this may provide valuable information with practice implications. Specifically, given the brightening effect found in other studies with individuals with MDD (e.g., Bylsma et al., 2011), we also predict that participation in the study will result in greater reductions in pre- to post negative affect and negative state anxiety for those in the MDD group compared to the control group.

2. Method

2.1. Participants

Participants were recruited using electronic advertisements (e.g., Craigslist) and flyers dispersed in the Tampa Bay area. Participants were first screened over the phone for initial eligibility criteria, and then scheduled for a research session to complete the protocol if they met the inclusion criteria and did not meet the exclusion criteria. The final sample included 50 adults who completed the protocol, 25 in the Major Depressive Disorder (MDD) group, and 25 in the never depressed control group. Reasons for exclusion at telephone screening or during the structured interview included medication for reported diagnosed high blood pressure, diagnosed cardiovascular disease, use of beta-blockers, substance abuse occurring within 6 months of the study entry, or history of psychotic symptoms. Inclusion in the Major Depressive Disorder (MDD) group required a clinician diagnosis of current MDD as determined by the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; First et al., 2002). Within our MDD group, all participants endorsed the depressed mood criterion and 88% endorsed the anhedonia criteria of MDD. Individuals in the control group were required to have no lifetime history of a Depressive Disorder, as well as no other current Axis I Disorders. Neither MDD nor control participants were excluded for having a medical concern other than those known to interfere with psychophysiological reactivity. MDD participants using one psychotropic medication were included (Anti-Depressant: $n = 3$; Anxiolytic: $n = 2$; Antipsychotic: $n = 1$), but those taking a combination of psychotropic medications were excluded. The sample was diverse in terms of demographic characteristics as can be seen in Table 1. The only differences in the demographic variables between the two groups were in education completed and employment status (all other demographics, $p > .10$). Participants were compensated \$25 per hour for participation in the study. On average, participants were in the lab for a total of two to three hours to complete the study protocol. All procedures were approved by the New England Institutional Review Board.

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