The Pennsylvania State University

The Graduate School

College of the Liberal Arts

WORRY AMPLIFIES THEORY-OF-MIND REASONING OF NEGATIVELY VALENCED SOCIAL STIMULI IN GENERALIZED ANXIETY DISORDER

A Thesis in

Psychology

by

Nur Hani Zainal

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Master of Arts

December 2017

The thesis of Nur Hani Zainal was reviewed and approved* by the following:

Michelle G. Newman
Professor of Clinical Psychology
Thesis Adviser

Amy Marshall
Associate Professor of Clinical Psychology

Reginald Adams
Associate Professor of Social Psychology

Melvin Mark
Head of Department of Psychology and Professor of Social Psychology

* Signatures are on file in the Graduate School.

ABSTRACT

Background: Theory-of-mind (ToM) is the ability to accurately infer others' thoughts and feelings. In generalized anxiety disorder (GAD), ToM is likely to be conditional on the degree of individuals' state worry, a hallmark symptom. However, no experiments have directly tested such interactional hypotheses, and used ToM as a framework to advance understanding of social cognition in GAD. This study aimed to address this gap by primarily examining the *interactional* effect of state worry and trait GAD. **Method:** 171 participants (69 GAD, 102 Controls) were randomly assigned to either a Worry or Relaxation induction and completed two well-validated ToM decoding (Reading the Mind in the Eyes Test) and reasoning (Movie for the Assessment of Social Cognition) tasks. **Results:** Clinical trait GAD significantly interacted with state worry to predict accuracy of overall reasoning, cognitive-reasoning, positive-reasoning, and negative-reasoning ToM. Worry, as opposed to relaxation, led GAD sufferers to display more accurate overall reasoning and cognitive-reasoning ToM than controls, especially for negative signals. GAD participants who worried, but not relaxed, were also significantly better than the norm at interpreting *negative* signals. These findings remained after controlling for gender, executive function, social anxiety, and depressive symptoms. For other ToM abilities, mean scores of persons with and without GAD who either worried or relaxed were normative. **Limitations:** The ToM reasoning measure lacked self-reference, and these preliminary findings warrant replication. **Conclusions:** Theoretical implications, such as the state worry-contingent nature of ToM in GAD, and clinical implications are discussed.

Keywords: generalized anxiety disorder, theory-of-mind, anxiety disorders, cognition, cognitive behavioral therapy

TABLE OF CONTENTS

List of Tables……….……….……….……….……….……….……….………... v
List of Figures……….……….……….……….……….……….……….….…….. vi

Acknowledgements……….……….……….……….……….………………...… vii

INTRODUCTION……….……….……….……….……….……….……..……... 1
Method……….……….……….……….……….……….……………………….. 5
Results……….……….……….……….……….……….…………………… 15
Discussion……….……….……….……….……….……….………………...… 24

Bibliography……….……….……….……….……….……………..………..….. 28

LIST OF TABLES

Table 1. Descriptive socio-demographic, clinical, and academic characteristics……. 7

Table 2. Comorbidity with other DSM-IV-TR-defined Axis I disorders……………. 8

Table 3. Multiple linear regression model predicting for accuracy on MASC……... 17

LIST OF FIGURES

Figure 1. Group × Condition statistically significant interaction predicting accuracy of ToM reasoning on the MASC………..………..………..………..………..……... 17

Figure 2. Group × Condition interaction marginally significantly predicting for accuracy of ToM reasoning of characters' emotions on the MASC.………..……… 19

Figure 3. Group × Condition statistically significant interaction predicting accuracy of ToM cognitive-reasoning on the MASC.………..………..………..…………….. 20

Figure 4. Group × Condition statistically interaction predicting accuracy of ToM reasoning for negatively valenced social stimuli on the MASC.………..………..… 22

Figure 5. Group × Condition statistically interaction predicting accuracy of ToM reasoning for positively valenced social stimuli on the MASC.………..….……..… 23

ACKNOWLEDGEMENTS

I sincerely thank Prof. Michelle Newman for her invaluable guidance in the preparation of this manuscript, for the helpful feedback, and hours invested into proofreading this thesis. I am also grateful for the support of my research assistants, Emily Forcht, Jenelle A. Richards, Marietta Kocher, Madeleine Lee Miller, and Kandace Tania Schaffer, in facilitating the data collection process.

INTRODUCTION

Theory-of-mind (ToM) refers to the ability to accurately infer others' internal states such as intentions and emotions that drive observable behaviors (Premack & Woodruff, 1978). Two components, decoding (social perceptual) and reasoning (social cognitive), are embodied within ToM (Sabbagh, 2004). *Decoding* involves deciphering others' tangible social information (e.g., eye gaze; Samson, 2009). *Reasoning* entails inferring individuals' motives, feelings, and beliefs. This includes predicting characters' actions based on inferences about their false beliefs, or discerning jokes from sarcasm. ToM combines both bottom-up mind-reading of information from dynamic environmental changes, as well as top-down schema-driven processing based on knowledge of a person's experiences, learning history, and belief systems. Lesion and neuroimaging studies have supported these dual-components of ToM, implying that distinct neural networks are intrinsically linked to ToM decoding and reasoning. Whereas static tasks such as the reading the mind in the eyes test (RMET; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001) assess ToM decoding, ecologically valid paradigms such as the movie for the assessment of social cognition (MASC; Dziobek et al., 2006) measure ToM reasoning. With respect to psychopathology, ToM deficits manifest in the form of either *over-attributing* mental states (e.g., excessive ToM in social anxiety disorder; Hezel & McNally, 2014) or making *inadequate* mental state inferences (e.g., autism spectrum disorders; Baron-Cohen et al., 2001). To our knowledge, no studies have explicitly investigated ToM in generalized anxiety disorder (GAD), a condition where excessive and uncontrollable worry is the hallmark symptom.

Although no studies have examined ToM in those with GAD, some indirect evidence may speak to this. Interpersonal problems have been linked to its etiology and maintenance (Newman & Erickson, 2010). For example, GAD persons were more likely than controls to either under- or over-estimate their impact and hostile behaviors on others (Erickson & Newman, 2007). However, support for no ToM impairment includes evidence that GAD persons were similar to controls in social competence, and involvement (Scharfstein, Alfano, Beidel, & Wong, 2011) as well as at recognizing basic and intricate facial expressions from context-absent stationary pictures (Yoon, Kim, Kim, Lee, & Lee, 2016). A recent meta-analysis found unimpaired emotion recognition in GAD (Plana, Lavoie, Battaglia, & Achim, 2014). Similarly, across cultures, worry showed no significant link to comprehension of an array of emotional faces on static photographs, which mimics ToM decoding measures (Baron-Cohen et al., 2001; Cooper, Rowe, & Penton-Voak, 2008; Surcinelli, Codispoti, Montebarocci, Rossi, & Baldaro, 2006; Yoon et al., 2016). Taken together, these data suggest that persons with GAD have intact ToM reasoning and decoding capacities.

At the same time, indirect evidence alludes to superior ToM capacities among GAD persons. In terms of affective reasoning (understanding others' emotions), compared to non-anxious persons, GAD analogues reported enhanced empathy for others' pain (Peasley, Molina, & Borkovec, 1994). Such empathy was also illustrated in Erickson & Newman (2007), when GAD persons showed stronger sad responses than controls to negative emotional disclosures by confederates. Empathy refers to the propensity to reflexively emulate and synchronize postures, expressions, or vocalizations, and thus, connect emotionally and viscerally with others' experiences (Hatfield, Cacioppo, & Rapson, 1993). Elevated empathy among high trait GAD persons hence likely signifies heightened affective-reasoning ToM accuracy (Tibi-Elhanany & Shamay-Tsoory, 2011). As those with GAD worry more chronically than their less severe counterparts, inducing worry among GAD persons may heighten sensitivity to various emotions and generalize to other more complex cues. However, this conjecture has not been tested directly. Indirect evidence for this speculation is derived from accounts of chronic worriers showing more rapid detection of disgusted, angry, neutral, and happy faces following priming of a fearful image, as opposed to benign stimuli (Olatunji, Ciesielski, Armstrong, & Zald, 2011). Fear resembles state worry. If these assumptions are true, GAD persons' attunement to their social environment and ToM skills may be sharpened when they engage in an acute state of worry. Taken together, state worry may intensify affective-reasoning ToM in those with GAD more strongly than non-anxious controls.

GAD persons also may be proficient at cognitive-reasoning ToM when worried. Worry is a cognitive-elaborative process in those with GAD (Borkovec & Inz, 1990), which could heighten the ability to infer others' thought processes (Brothers & Ring, 1992). Plana et al. (2014) found large effect sizes for negative social attributional style in GAD. This is consistent with heightened attention to ambiguous aspects of their social environment as a result of state worry in clinical GAD (Hirsch, Hayes, & Mathews, 2009). Using functional neuroimaging (fMRI), GAD persons also had elevated bilateral connectivity between the amygdala and executive control networks (e.g., ventromedial prefrontal cortex [vm-PFC]) which was not observed in controls (Etkin, Prater, Schatzberg, Menon, & Greicius, 2009; Mochcovitch, da Rocha Freire, Garcia, & Nardi, 2014). Such tight amygdala-frontoparietal network coupling may indicate a habit of recruiting the cognitive control system as a form of elevated vigilance for comprehending others' motives and intentions. Similar to findings for depressive realism (Alloy & Abramson, 1979), such vigilance in GAD could hence lead to heightened accuracy in their cognitive-reasoning ToM. Pulling these findings together, we conjecture that persons with GAD may have keen cognitive-reasoning ToM skills when engaged in worry.

Negative versus positive context may also matter, as GAD persons were more skillful than controls in identifying angry faces, specifically amid a sea of distracter neutral faces, instead of happy faces (Ashwin et al., 2012). Indeed, across a diversity of paradigms, worry led GAD individuals to show vigilance toward social threats (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). At the same time, lower state worry was linked to the propensity to naturally attend to positive social features and interpret ambiguous social signals in a positive light (Frewen, Dozois, Joanisse, & Neufeld, 2008). Furthermore, worry severity and vigilance to social threat were reduced following relaxation training (Fonzo et al., 2014). Taken together, degree of engagement in state worry and relaxation may interact with trait GAD to determine ToM accuracy for positive and negative social signals. Relaxation, a core component of cognitive behavioral treatment, fosters GAD persons' ability to access both positive and negative meanings of the social environment. We would thus anticipate that *relaxation* would engender *comparable* ToM for *positive* social material between persons with and without GAD. We would also expect GAD individuals' strong accuracy to read *negative* social cues to be present uniquely in a state of heightened *worry*.

In summary, the foregoing theories and data suggest that effects based solely on GAD status may not reflect the complex reality of ToM processes. Plausible hypotheses of how GAD moderates ToM capacities are likely to be conditional on participants' degree of state worry, which may be controlled by inducing either worry or relaxation in a laboratory setting. To address a knowledge gap, the goal of this experimental study was to test the interactional link between state worry and trait

GAD on ToM reasoning and decoding. Persons with GAD have heightened sensitivity to a diversity of context-specific social cues (Bui et al., 2017; Olatunji et al., 2011). As such, we hypothesized that GAD and state worry would interact to facilitate greater awareness of social cues, resulting in higher ToM *reasoning*. However, we predicted no effects of GAD or worry on *decoding* accuracy, as studies that used static context-absent ToM-like tasks (e.g., Yoon et al., 2016) found no link with GAD diagnostic status. Second, we predicted based on research on worry and empathy that persons with GAD would demonstrate heightened *affective-reasoning* ToM when worried. Third, we predicted that GAD status and state worry would operate in tandem to predict better *cognitive-reasoning* ToM than controls based on fMRI data regarding those with GAD when worried. Fourth, since state worry intensifies focus on threats (Hirsch et al., 2009), we expected that worry exposure would lead the GAD group to be more accurate than controls for negative aspects of social interactions. Lastly, psychotherapy helped GAD persons to balance their cognitive processing of both positive and negative signals. We thus expected that relaxation would lead controls and persons with GAD to show non-significantly different and intact ToM decoding and reasoning for positive social stimuli.

Method

Overall Design

A 2 (Group: GAD, non-anxious Controls) by 2 (Condition: Worry, Relaxation) between-group block design was employed to explore the differential effects of worry on ToM reasoning and decoding. Cell size was determined *a priori* by a power analysis based on a between-group medium effect size (d = 0.50). Assuming α = .05 (two-tailed), 30 participants per condition ensured power of .80 for detecting between-group differences (Neter, Wasserman, & Kutner, 1990). In the relaxation condition, 53 were Controls, whereas 38 met criteria for GAD. In the worry condition, 49 were Controls, whereas 31 had GAD.

Participants

One-hundred-and-seventy-one undergraduates (138 females; *M* age = 18.96 years, *SD* = 1.16 years) participated in exchange for course credit. Ethnic distribution was 80.70% Caucasian, 5.85% African American, 2.92% Hispanic, 0.58% Middle Eastern, and 9.94% Asian. Based on the Generalized Anxiety Disorder Questionnaire-IV (scored above the 5.7 cutoff on the GAD-Q-IV (*M* = 7.53, *SD* = 1.54); Newman et al., 2002) and Mini International Neuropsychiatric Interview (i.e., endorsed excessive and uncontrollable worry for at least 6 months; Sheehan et al., 1997), 69 people met criteria for GAD, and 102 were non-GAD controls. Demographic and comorbidity data are reported in Tables 1 and 2 respectively.

Table 1

Descriptive socio-demographic, clinical, and academic characteristics.

	Control		GAD		Statistics	*p*	*d*
	M	(*SD*)	*M*	(*SD*)			
	n = 102		*n* = 69				
Age	19.04	(1.19)	18.84	(1.106)	$t(169) = 1.10$	.27	0.17
Females	75	(73.53)	63	(91.30)	$\chi^2(1) = 8.35$	**.0039**	**0.45**
White Caucasians	74	(72.55)	58	(84.06)	$\chi^2(1) = 3.10$	.078	0.27
GPA	3.34	(0.56)	3.28	(0.60)	$t(169) = 0.62$	.54	0.095
GADQ-IV total	1.21	(1.09)	7.53	(1.54)	$t(169) = –31.42$	**< .00001**	**4.83**
PSWQ total	44.89	(12.89)	75.32	(11.85)	$t(169) = –15.64$	**< .00001**	**2.41**
BDI-II total	22.25	(3.52)	34.10	(9.68)	$t(169) = –9.74$	**< .00001**	**1.50**
SPDQ total	20.49	(6.19)	30.31	(9.89)	$t(169) = –7.33$	**< .00001**	**1.13**
WCST total	42.89	(8.57)	43.33	(9.10)	$t(169) = –0.32$	.75	0.049
MASC	34.07	(3.50)	34.46	(3.26)	$t(169) = –0.73$	.47	0.11
RMET	12.36	(2.08)	12.62	(2.31)	$t(169) = 0.97$	.33	0.15

Note. GPA = grade point average; GADQ-IV = generalized anxiety disorder questionnaire – fourth edition; PSWQ = Penn State worry questionnaire; BDI-II = Beck depression inventory – second version; SPDQ = social phobia diagnostic questionnaire; WCST = Wisconsin card sorting test; MASC = movie for the assessment of social cognition; RMET = reading the mind in the eyes test.

Table 2

Comorbidity with other DSM-IV-TR-defined Axis I disorders.

	Non-GAD		**GAD**		**χ^2(1)**	***p***	***d***
	n	(%)	*n*	(%)			
Major Depressive Disorder Current	3	(2.94)	12	(17.39)	10.74	**.001**	**0.52**
Major Depressive Disorder Lifetime	1	(0.98)	6	(8.70)	6.24	**.012**	**0.39**
Hypomanic Episode	7	(6.86)	16	(23.19)	9.42	**.002**	**0.48**
Panic Disorder Lifetime	6	(5.88)	19	(27.54)	15.46	**.00008**	**0.63**
Agoraphobia without Panic Disorder	3	(2.94)	14	(20.29)	13.84	**.0002**	**0.59**
Social Phobia	4	(3.92)	12	(17.39)	8.81	**.003**	**0.47**
Obsessive Compulsive Disorder	0	(0.00)	4	(5.80)	6.06	**.014**	**0.38**
Substance Abuse/ Dependence	10	(9.80)	11	(15.94)	1.44	.23	0.18
Bulimia Nervosa	2	(1.96)	4	(5.80)	1.79	.18	0.21

Note. DSM-IV-TR = diagnostic and statistical manual – fourth version – text revised.

Clinical Interview and Self-Report Measures

Mini International Neuropsychiatric Interview (MINI; Sheehan et al., 1997). The MINI is based on the DSM-IV (American Psychiatric Association, 2013) and International Classification of Diseases – 10th Edition (ICD-10) and has been validated against the Composite International Diagnostic Interview (CIDI; Robins et al., 1988) and Structured Clinical Interview for DSM Disorders (SCID; First, Spitzer, Gibbon, & Williams, 1997). It is a brief but accurate structured clinical interview designed to be used by paraprofessionals. Inter-rater agreement was $\kappa = .70$ for GAD and ranged from .50 (simple phobia) to .90 (anorexia) for other disorders. Sheehan et al. (1998) showed the sensitivity of the MINI to be $\geq .70$ for all diagnoses but dysthymia (.62) and obsessive-compulsive disorder (.67), whereas specificities were $\geq .85$ for all diagnoses. The MINI was administered by trained undergraduates, supervised by a doctoral-level licensed clinical psychologist. Each interview was observed in-session by a second rater to independently evaluate whether participants met diagnostic criteria. Reliability was good across all mental disorders (Cohen's kappa: $\kappa = .93$, $p < .001$) and the GAD diagnosis in particular ($\kappa = .97$, $p < .001$).

Generalized Anxiety Disorder Questionnaire (GADQ-IV; Newman et al., 2002). This 14-item measure is used to screen for DSM-IV and DSM-5-defined GAD (American Psychiatric Association, 2013). A cut-off score of 5.7, used in this study, leads to a specificity and sensitivity of .89 and .83 respectively (Newman et al., 2002). Internal consistency (α = .94; .90 in the current study) and retest reliability of .92 are good. Also, the scale has good convergent and discriminant validity, and κ agreement of .67 with a structured interview.

Penn State Worry Questionnaire – Past Week (PSWQ-PW; Stöber & Bittencourt, 1998). The PSWQ-PW is a 15-item measure of an individual's frequency and intensity of pathological worry over the past week. It was adapted from the original 16-item PSWQ, which measures *trait* worry, in contrast to *state* worry (Meyer, Miller, Metzger, & Borkovec, 1990). It is rated on a 7-point Likert scale from ‘never’ to ‘almost always’. Scores range from 0 to 90, with higher scores signifying more worry. It has good internal consistency, ranging from .84 to .93 (.95 in this study) over a four-week assessment period (Stöber & Bittencourt, 1998), as well as convergent validity with the past-week version of the Worry Domains Questionnaire (WDQ; Tallis, Eysenck, & Mathews, 1992).

*Social Phobia Diagnostic Questionnaire (SPDQ; Newman, Kachin, Zuellig, Constantino, & Cashman-McGrath, 2003)***.** This 25-item measure of DSM-IV-TR-defined social anxiety disorder (SAD) has a sensitivity and specificity of .82 and .85 respectively when compared with a structured interview. It has excellent internal consistency ($\alpha = .92$; .95 in the current study) and good 2-week retest reliability ($\kappa = .63$). It also has strong convergent validity with the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998; point-biserial $r = .64$), and demonstrated discriminant validity with the PSWQ ($r = .32$), GADQ-IV ($r = .29$), and other psychopathology measures (Newman et al., 2003).

Beck Depression Inventory–II (BDI-II; Beck, Steer, & Brown, 1996). This 21-item self-report measure taps into depressive symptom severity. For each item, individuals endorse the most suitable of four statements of greater intensity (0–3), based on the past two weeks. The total score ranges from 0 to 63. It has excellent internal consistency ($\alpha = .92$–.93; .94 in the current sample) and good validity (Beck et al., 1996).

Theory-of-Mind and Executive Function Measures

Reading the Mind in the Eyes Test (RMET; Baron-Cohen et al., 2001) – ToM decoding. The RMET is a sophisticated ToM decoding task that requires people to recognize others’ thoughts and emotions with the eyes only. Each of the 18 pictures is 15 cm by 6 cm and depicts faces only from the middle of the nose to just above the eyebrows. Participants select one of four words (one target and three foils), which most accurately describe the individual’s mental state or emotion in the photograph (e.g., decisive, bored) (one point per correct response). Location of the target answer is counterbalanced and all words are equally spaced from the center. Higher scores indicate better ToM decoding (score range 0–18). It has acceptable internal consistency (Cronbach's alpha = .61; Vellante et al., 2013) and excellent retest reliability (intra-class correlation coefficient of .83; Vellante et al., 2013). RMET options are either positive or negative in valence (cf. Hezel & McNally, 2014).

Movie for the Assessment of Social Cognition (MASC; Dziobek et al., 2006) – ToM reasoning. The MASC assesses ToM reasoning via a 15-minute video about four people at a dinner gathering. Characters demonstrate stable traits throughout the movie (e.g., extraverted, timid, selfish) and confront different social scenarios that trigger varied mental states, emotions, and responses (e.g., disgust, anger, jealousy, sarcasm). Intimacy level between characters differ, as they are either friends or strangers. The movie was paused during 45 preset times and participants were questioned regarding characters' intentions, thoughts, and feelings. The MASC encompasses perspectives of social cognition such as faux pas, irony, humor, and first- and second-order false beliefs (for more details see Dziobek et al., 2006).

Questions follow a multiple-choice format. Answers were classified into four categories: (1) "correct ToM": correct mental states inferred, (2) "no ToM": no mental states inferred (i.e., physical causation), (3) "less ToM": mental states inferred inadequately, and (4) "excessive ToM": high degrees of mental states inferred. To illustrate, Cliff is the first guest to arrive at Sandra's party. They both seem to be enjoying their conversation as Cliff talks about his holiday in Sweden. Upon his arrival, Michael tries to seize Sandra's attention and purposefully excludes Cliff. Sandra starts to feel irritated with Michael, looks briefly at Cliff and then asks Michael if he has ever been to Sweden. The video pauses and participants answer: "Why is Sandra asking this?" "To integrate Cliff," is the correct response. Incorrect responses are "She liked the Sweden topic better than the current one." (no ToM), "To compare the two." (excessive ToM), and "To hear whether Michael also has something to say about Sweden." (less ToM). The MASC has internal consistency (Cronbach's $\alpha = .84$), inter-rater reliability (Cohen's $\kappa = .99$), and retest reliability ($r = 0.97$; Dziobek et al., 2006). It also has strong convergent validity with other social cognition measures (Dziobek et al., 2006).

Four composite scores, each reflecting one category, were calculated. The sum of correct responses reflected ToM reasoning accuracy. Using predefined categories developed by others, items were subdivided into cognitive- and affective-reasoning ToM. Example items were "What is (the person) feeling?" (i.e., affective-reasoning ToM; 18 items) and "What is (the person) thinking/ What is (the person's) intention?" (i.e., cognitive-reasoning ToM; 27 items; cf. Wilbertz, Brakemeier, Zobel, Härter, & Schramm, 2010). Six people also independently rated valence of the 180 responses (45 questions × 4 response selections) as either negative, neutral, or positive. 83 options were rated as negatively, 28 neutrally, and 69 positively valenced. There was agreement on 177 of the 180 items, resulting in $\kappa = .99$.

Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Kay, & Curtis, 1993). A computerized WCST measured executive function reflected by participants' cognitive flexibility to modify certain criteria using realistic constraints of the matching rule (i.e., when receiving feedback about wrong answers). Using an unspecified matching rule, participants matched stimulus cards to one of four principal cards. The test ends when participants make 60 attempts. Results were calculated based on the number of correct responses.

Manipulation Check Measure

Worry and relaxation (Fisher & Newman, 2013). Participants rated on two 9-point Likert scales their degree of worry and relaxation (1 = *not at all* to 9 = *as much as possible*).

Procedure

Participants provided informed consent as approved by the institutional review board. They were first interviewed using the MINI then completed the following questionnaires: demographics, GADQ-IV, PSWQ, BDI-II, and SPDQ. The computer then prompted them to rate their extent of current worry and relaxation. Subsequently, they were randomly assigned to either worry or relax using an Excel algorithm; at no point in time were research personnel able to anticipate the assignment. Instructions for the worry induction were as follows: "Think about your most worrisome topic. Please worry about this topic as intensely as you can, in the way that you usually worry, until you are asked to stop worrying. If at any point your mind wanders off track, simply refocus your thoughts back to your worry topic." The following instructions were given for the relaxation induction: "Shift to breathing from your stomach rather than from your chest. Allow your stomach to rise and fall without expanding your chest. Also, slow your breathing down to a rate slower than usual but not so slow that it is unpleasant or uncomfortable. You might do this by counting from one to three as you breathe in evenly and then again as you evenly exhale. If at any point your mind wanders, simply refocus your thoughts back to your breathing." These instructions were concordant with previous studies (e.g., Borkovec & Inz, 1990), and were practiced for three minutes. Participants again rated their degree of worry and relaxation post-induction. Then, following others (e.g., Hezel & McNally, 2014), they completed RMET, MASC and WCST in that order. Importantly, the worry and relaxation inductions were refreshed prior to each task. These tasks took about 240 minutes to complete and were done on a computer faced away from the examiner to minimize anxiety about being observed.

Data Analytic Plan

All analyses used SPSS (Statistical Package for Social Sciences, Version 20.0). Skewness and kurtosis fell within ± 1, suggesting normal distribution of the data. Outliers, defined as scores ± 3 standard deviations (SDs) above or below the mean, were absent. χ^2 tests compared differences in gender, race, and diagnoses (cf. Tables 1 and 2). For manipulation checks, multilevel modeling was conducted to account for nesting of persons within condition and nesting of repeated measures across time within each person

(Raudenbush & Bryk, 2002). Next, we conducted a series of 2 × 2 ANOVAs with Group (GAD, Control) and Condition (Worry, Relaxation) on accuracy of ToM decoding and reasoning (Hypothesis 1), cognitive-reasoning and affective-reasoning ToM (Hypotheses 2 and 3), as well as negative and positive social stimuli (Hypotheses 4 and 5). All ToM accuracy scores were based on percentages of correct responses. ToM reasoning errors (excessive, less, and no ToM) were coded in terms of absolute scores. Significant interaction effects were followed by a series of *t*-tests to clarify the pattern of means. Analyses of covariance (ANCOVAs) were conducted to test robustness of any significant finding by adjusting for the following theoretically and empirically-based covariates: gender (Baron-Cohen et al., 2001), executive function (Zobel et al., 2010), social anxiety (e.g., Hezel & McNally, 2014), and depression (Harkness, Jacobson, Duong, & Sabbagh, 2010). Statistically significant univariate findings were considered robust if they remained significant after controlling for these covariates. No ANCOVAs presented with issues of multicollinearity, as reflected by values of tolerance greater than .20 and variance inflation factors of less than 4 for all predictors (Aiken & West, 1991). All *p* values were based on two-tailed tests. Cohen's *d* effect sizes were calculated using the following formulas: $\frac{2t}{\sqrt{(df)}}$ or $2\sqrt{\frac{F}{(df)}}$ (i.e., small = 0.20, medium = 0.50, large = 0.80; Aiken & West, 1991; Cohen, 1992). For the ANOVA-derived *F*-tests, we also calculated the partial eta squared (η_p^2) effect size (i.e., proportion of the effect plus error variance that is due to the effect; Fritz, Morris, & Richler, 2012). Although unequal cell sizes do not affect parameter estimates for multilevel modeling (Maas & Hox, 2005), it may introduce concerns for ANOVAs regarding unequal variances. We thus verified that Levene's tests of equality of error variances were statistically non-significant ($p > .05$), reflecting similar variances across groups. For significant findings, we also compared our computed item averages from the RMET or MASC to norms (item means and SD of controls) provided by the test developers (Baron-Cohen et al., 2001; Dziobek et al., 2006).

For this, we converted means into standardized *z*-scores. Means that were significantly different from the norms were reflected by values that surpassed the $z = \pm 1.96$ critical value.

Results

Manipulation Checks

As indicated by significant condition × time interaction effects, worry induction led to sharper increases in levels of self-reported worry compared to relaxation prior to administration of the RMET [$F(1, 340) = 53.78$, $p < .0001$, $d = 0.80$], MASC [$F(1, 340) =$ $F(1, 340) = 27.12$, $p < .0001$, $d = 0.56$], and WCST [$F(1, 340) = 33.91$, $p < .0001$, $d = 0.63$]. Similarly, significant condition × time interaction effects reflected that the relaxation induction predicted steeper increases in self-reported relaxation relative to worry before the RMET [$F(1, 340) = 29.29$, $p < .0001$, $d = –0.59$], MASC [$F(1, 340) = 13.08$, $p < .0001$, $d = –0.39$], and WCST [$F(1, 340) = 15.72$, $p < .0001$, $d = –0.43$] were administered. Taken together, analyses indicated that the manipulations worked.

Hypothesis 1: State worry, as opposed to relaxation, would result in the GAD group demonstrating more accurate ToM reasoning, but not decoding, than controls. A significant group × condition interaction emerged for ToM reasoning [moderate effect size; $F(1, 167) = 8.20$, $p = .0047$, $\eta_p^2 = .047$] but not decoding [$F(1, 167) = 2.25$, $p = .14$, $\eta_p^2 = .013$].[1] In the context of the worry, ToM reasoning was significantly more accurate among the GAD group ($M = 78.76$) relative to controls ($M = 74.31$) [$t(169) = 2.45$, $p = .014$, $d = 0.56$]. However, after relaxation, those with GAD ($M = 74.61$) and controls ($M = 76.78$) did not differ in ToM reasoning accuracy [$t(169) = –1.49$, $p = .14$, $d = –0.32$]. Furthermore, compared to relaxation, worry led to *higher* ToM reasoning accuracy among the GAD ($M_{WORRY} = 78.76$ versus $M_{RELAX} = 74.61$) [$t(169) = 2.56$, $p = .013$, $d = 0.64$] but not the

[1] The interaction effect remained significant in a similar magnitude and direction after accounting for gender, executive function, depressive, and social anxiety symptoms [$F(1, 159) = 6.78$, $p = .010$, $\eta_p^2 = 0.041$; refer to Table 3].

control group (M_{WORRY} = 74.31 versus M_{RELAX} = 76.78) [$t(169) = -0.98$, $p = .33$, $d = -0.20$]. However, ToM reasoning accuracy scores of all groups were not significantly above the norms [GAD participants: worry (+ 0.815 SD), relax (+ 0.096 SD); Controls: worry (+ 0.044 SD), relax (+ 0.001 SD)]. Hypothesis 1, was fully supported (see Figure 1).

Figure 1

Group × Condition statistically significant interaction predicting accuracy of ToM reasoning on the MASC.

Note. MASC = movie for the assessment of social cognition; ToM = theory-of-mind; Regression statistics for two-way interaction effect: $b = 0.98$, SE = 0.34, $t = 2.86$, $p = .0047$, $d = 0.44$.

Table 3

Multiple linear regression model predicting for accuracy on MASC.

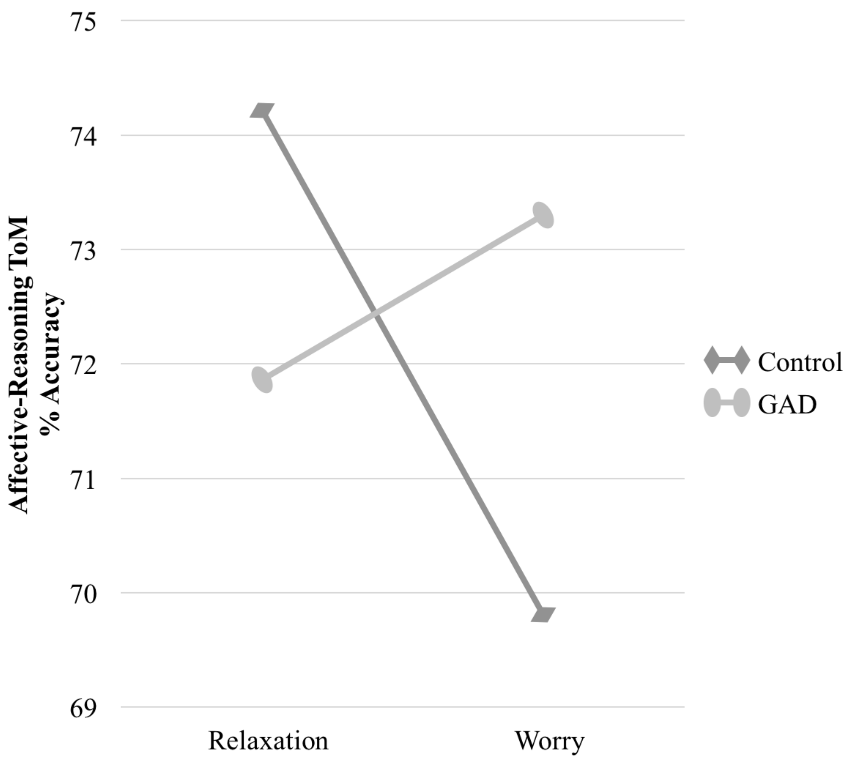
	b	(*SE*)	*t*	*p*	*d*
Intercept	75.53	(4.19)	18.04	< .001	
Group	-0.17	(0.31)	-0.56	.58	0.09
Condition	-2.82	(1.79)	-1.57	.12	0.25
Group × Condition	0.93	(0.36)	2.60	**.01**	**0.41**
Gender	-1.07	(1.55)	-0.69	.49	0.11
Executive function	0.11	(0.07)	1.62	.11	0.26
Social anxiety severity	-0.01	(0.09)	-0.16	.87	0.03
Depression severity	-0.08	(0.11)	-0.72	.47	0.11

Note. MASC = movie for the assessment of social cognition; Executive function was measured using the Wisconsin card sorting test; Social anxiety was measured using the Social phobia diagnostic questionnaire; Depression was measured using the Beck depression inventory – second version.

Hypothesis 2: State worry would lead to persons with GAD showing stronger performance compared to controls on affective-reasoning ToM accuracy. The group × condition interaction effect on affective-reasoning ToM accuracy was marginally significant [$F(1, 167) = 3.34$, $p = .069$, $\eta_p^2 = .019$] (Figure 2). Those with GAD were non-significantly different than controls in affective-reasoning ToM following relaxation ($M_{GAD} = 71.86$ versus $M_{CONTROL} = 74.22$) [$t(169) = –1.14$, $p = .26$, $d = –0.24$] and worry ($M_{GAD} = 73.30$ versus $M_{CONTROL} = 69.80$) [$t(169) = 1.43$, $p = .16$, $d = 0.33$], lending no support to Hypothesis 2. Whereas state worry and relaxation showed no significant differential impact on GAD persons' ability to reason about others' emotions ($M_{WORRY} = 73.30$ versus $M_{RELAX} = 71.86$) [$t(169) = 0.70$, $p = .49$, $d = 0.17$], controls were marginally significantly better at affective-reasoning ToM following *relaxation* than worry ($M_{WORRY} = 69.81$ versus $M_{RELAX} = 74.22$) [$t(169) = –1.77$, $p = .08$, $d = –0.36$]. All groups scored non-significantly below the norms on affective-reasoning ToM [GAD group: worry (–0.40 SD), relax (–0.69 SD); Control group: worry (–0.90 SD), relax (–0.29 SD)]. However, controls' affective-reasoning ToM was closest to the norm when they relaxed. Therefore, although controls showed superior affective-reasoning ToM after relaxation compared to worry, their scores were normative.

Figure 2

Group × Condition interaction marginally significantly predicting for accuracy of ToM reasoning of characters' emotions on the MASC.



Note. MASC = movie for the assessment of social cognition; ToM = theory-of-mind; Regression statistics for two-way interaction effect: $b = 0.87$, SE = 0.47, $t = 1.83$, $p = .069$, $d = 0.28$.

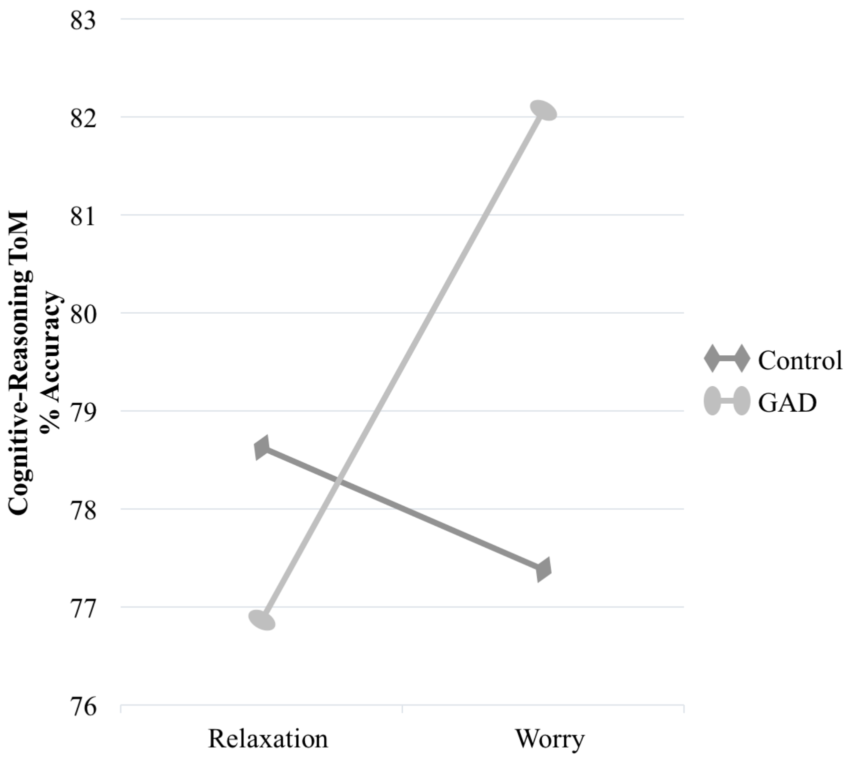
Hypothesis 3: State worry, but not relaxation, would lead GAD individuals to be more accurate than non-anxious controls for cognitive-reasoning ToM. We observed a significant group × condition interaction effect on cognitive-reasoning ToM accuracy [$F(1, 167) = 4.80$, $p = .030$, $\eta_p^2 = .028$] (Figure 3).[2] GAD persons were significantly more accurate

[2] Similarly, in determining cognitive ToM accuracy, the group × condition interaction effect was marginally significant and in the same direction after controlling for the four covariates [$F(1, 159) = 3.76$, $p = .054$, $\eta_p^2 = 0.024$].

than controls after worry (M_{GAD} = 82.07 versus $M_{CONTROL}$ = 77.38) [$t(169) = 2.05$, $p = .044$, $d = 0.47$] but not relaxation (M_{GAD} = 76.87 versus $M_{CONTROL}$ = 78.63) [$t(169) = –0.93$, $p = .35$, $d = –0.20$]. Compared to relaxation, worry enhanced cognitive-reasoning ToM among GAD participants (M_{WORRY} = 82.07 versus M_{RELAX} = 76.87) [$t(169) = 2.11$, $p = .039$, $d = 0.53$] but not non-anxious controls (M_{WORRY} = 77.38 versus M_{RELAX} = 78.63) [$t(169) = 0.016$, $p = .99$, $d = 0.0032$]. All groups scored non-significantly above the norms on cognitive-reasoning ToM [GAD participants: worry (+ 1.11 SD), relax (+ 0.27 SD); Control group: worry (+ 0.404 SD), relax (+ 0.400 SD)]. Hypothesis 3 was thus fully supported.

Figure 3

Group × Condition statistically significant interaction predicting accuracy of ToM cognitive-reasoning on the MASC.



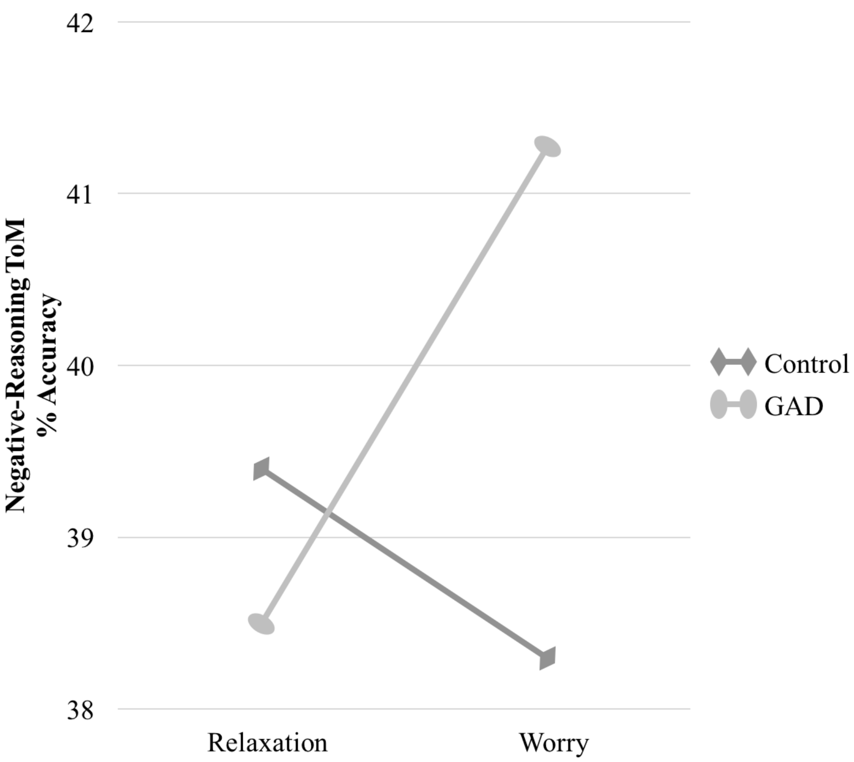
Note. MASC = movie for the assessment of social cognition; ToM = theory-of-mind; Regression statistics for two-way interaction effect: $b = 0.96$, SE = 0.44, $t = 2.19$, $p = .030$, $d = 0.34$.

Hypothesis 4: State worry, but not relaxation, would cause persons with GAD to have better ToM reasoning and decoding on negative social stimuli than controls. For ToM accuracy on negative social stimuli, analyses yielded a significant group × condition interaction effect on ToM reasoning [$F(1, 167) = 7.24$, $p = .0079$, $\eta_p^2 = .042$] but not decoding [$F(1, 167) = 1.48$, $p = .23$, $\eta_p^2 = .009$] (Figure 4).[3] Compared to relaxation, ToM reasoning on negative social stimuli was significantly better following *worry* among those with GAD ($M_{\text{WORRY}} = 41.28$ versus $M_{\text{RELAX}} = 38.49$) [$t(169) = 2.66$, $p = .01$, $d = 0.66$] but not controls ($M_{\text{WORRY}} = 38.29$ versus $M_{\text{RELAX}} = 39.40$) [$t(169) = 0.48$, $p = .63$, $d = 0.097$]. Relative to controls, those with GAD had better ToM reasoning for negative stimuli following worry ($M_{\text{GAD}} = 41.28$ versus $M_{\text{CONTROL}} = 38.29$) [$t(169) = 2.88$, $p = .0051$, $d = 0.65$] but not relaxation ($M_{\text{GAD}} = 38.49$ versus $M_{\text{CONTROL}} = 39.40$) [$t(169) = –0.92$, $p = .36$, $d = 0.20$]. All participants' ToM reasoning accuracy on negative social signals were above the norms [GAD participants: worry (+ 2.72 SD), relax (+ 1.67); Non-anxious controls: worry (+1.77 SD), relax (+ 1.95 SD)]. However, the GAD group who worried was the only group that showed ToM reasoning accuracy on negative stimuli that was significantly above the norm. Thus, Hypothesis 4 was supported for ToM reasoning but not decoding.

Figure 4

Group × Condition statistically interaction predicting accuracy of ToM reasoning for negatively valenced social stimuli on the MASC.

[3] The group × condition effect predicting ToM reasoning accuracy on *negative* stimuli remained statistically significant in the same direction after controlling for the four covariates [$F(1, 159) = 5.89$, $p = .016$, $\eta_p^2 = .036$, $d = 0.38$].



Note. MASC = movie for the assessment of social cognition; ToM = theory-of-mind; Regression statistics for two-way interaction effect: b = 0.58, SE = 0.21, t = 2.69, p = .0079, d = 0.42.

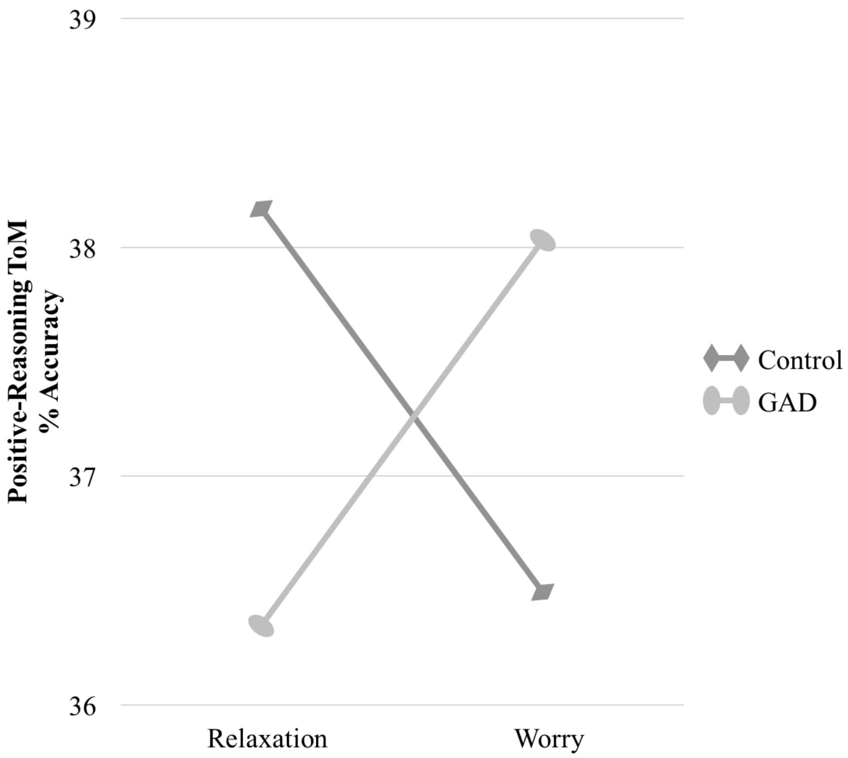
Hypothesis 5: State relaxation would lead controls and persons with GAD to show non-significantly different and intact ToM decoding and reasoning for positive social stimuli. For ToM accuracy of *positively* valenced social stimuli, there was a group × condition interaction for ToM reasoning [$F(1, 167) = 4.73$, $p = .031$, $\eta_p^2 = .028$] but not decoding [$F(1, 167) = 1.20$, $p = .27$, $\eta_p^2 = .007$] (Figure 5).[4] Worry or relaxation yielded similar ToM reasoning on positively valenced social stimuli among the GAD group (M_{WORRY} = 38.03 versus M_{RELAX} = 36.36) [$t(169) = 1.49$, $p = .22$, $d = 0.37$] and non-anxious controls (M_{WORRY} = 36.49 versus M_{RELAX} = 38.17) [$t(169) = –1.24$, $p = .22$, $d = –0.25$]. Following worry induction, no significant differences were noted between those with GAD (M = 38.03)

[4] Upon examining ToM reasoning accuracy on positive social stimuli as the outcome, the group × condition interaction effect became marginally significant, but in similar direction after adjusting for the four covariates [$F(1, 159) = 3.89$, $p = .050$, $\eta_p^2 = .024$, $d = 0.31$].

and controls (*M* = 36.49) [*t*(169) = 1.23, *p* = .22, *d* = 0.28]. However, after relaxation, controls (*M* = 38.17) were marginally significantly better than those with GAD (*M* = 36.49) at ToM reasoning for positive stimuli [*t*(169) = –1.93, *p* = .057, *d* = –0.41]. ToM reasoning accuracy for positive material was non-significantly above the norm for all groups [GAD group: worry (+ 1.44 SD), relax (+ 0.99 SD); Control group: worry (+ 0.85 SD), relax (+ 1.53 SD)]. However, compared to the GAD group, controls excelled in positive-reasoning ToM when they relaxed, instead of worried, partially supporting Hypothesis 5.

Figure 5

Group × Condition statistically significant interaction predicting accuracy of ToM reasoning for positively valenced social stimuli on the MASC.



Note. MASC = movie for the assessment of social cognition; ToM = theory-of-mind; Regression statistics for two-way interaction effect: *b* = 0.50, SE = 0.23, *t* = 2.18, *p* = .031, *d* = 0.34.

Secondary Analyses of ToM Reasoning Errors

Analyses revealed no significant group × condition interaction effects on excessive ToM [$F(1, 167) = 1.55$, $p = .22$, $\eta_p^2 = .009$], less ToM [$F(1, 167) = 1.25$, $p = .27$, $\eta_p^2 = .007$] and no ToM [$F(1, 167) = 2.35$, $p = .13$, $\eta_p^2 = .014$]. No main group and condition effects were also observed for these three types of ToM reasoning errors (all $p > .05$).

Discussion

Overall, our data showed that trait GAD and state worry synergistically interacted to amplify accuracy for overall reasoning, cognitive-reasoning, and negative-reasoning, but not affective-reasoning ToM. Among controls, however, state relaxation led to more accurate affective-reasoning ToM than worry as well as better positive-reasoning ToM than the GAD group. Compared to the general population norm, overall reasoning, cognitive-reasoning, affective-reasoning, and positive-reasoning ToM of the GAD and control groups who worried or relaxed were normative. However, the GAD, but not control group who *worried*, as opposed to relaxed, were more accurate on *negative* ToM reasoning than controls and this was, on average, significantly *above* the norm. Importantly, this pattern of findings remained after controlling for multiple covariates, which raises our level of confidence in the findings herein. The overall pattern of results reflects that instead of being an enduring trait-like entity, ToM in both GAD and non-GAD control groups are momentarily impacted by state worry/relaxation. Data from this novel study provides fertile ground for theoretical development of the understudied phenomena of ToM in GAD.

Why were GAD individuals in a state of worry more accurate at various types of reasoning ToM than controls, whereas there were no differences between these groups in response to relaxation? The fact that worry enhanced GAD persons’ skill to attend to cues and accurately infer the internal states of the film’s characters on overall reasoning, cognitive-reasoning, and negative-reasoning may be linked to the verbal-cognitive nature of worry (Carter, Johnson, & Borkovec, 1986). Perhaps worry did not impact ToM reasoning in controls because in those without GAD, worry is characterized by more imagery than verbal-cognitive thought (Borkovec & Inz, 1990). Furthermore, functional neuroimaging (fMRI) studies consistently showed that worry induction activated the anterior cingulate cortex (ACC) and medial prefrontal cortex (mPFC) more strongly and persistently in GAD than controls (Andreescu et al., 2015; Paulesu et al., 2010). These areas have been implicated in social cognitive/reasoning, as opposed to social perceptual/decoding ToM (Frith & Frith, 2006), hence also accounting for our null findings on ToM decoding. In the GAD group, worry, once triggered, tends to be a self-perpetuating process cognitively (Pratt, Tallis, & Eysenck, 1997) and neurologically (Paulesu et al., 2010). Also, state relaxation presumably dampened GAD persons' inclination to abstract about the agents' intentions by curbing the mental expansive processing reinforced by worry.

Why did state worry versus relaxation not significantly interact with trait GAD to differentially impact ToM decoding, as it did for overall reasoning and cognitive-reasoning ToM? One possible explanation may be based on the nature of the paradigms. ToM decoding was measured with the RMET – a series of static pictures of people's eyes only. This task was devoid of contextual cues. The MASC, however, provides a wealth of social data which includes facial expressions, gestures, voice tone, speech rate, and body language. It has a meta-representational component unlike the eyes test. State worry may have facilitated GAD participants' hypervigilance to the multidimensional aspects of the social interactions unfolding within the movie. Relaxation, however, led GAD persons to be less vigilant, but still as attentive as controls and the general population, to the dynamic social scenarios in the video. Also, individuals with GAD made better use of these contextual hints than controls when engaged in worry. Plausibly, in GAD, worry functions to pick up intentions and beliefs more pointedly than controls and other forms of anxiety disorders. This interpretation is supported by studies showing that chronic worriers were better than controls in accuracy and speed on social cognition tests that provided some form of context, such as fear priming (Olatunji et al., 2011), negative emotional disclosures (Erickson & Newman, 2007), or background intensity (Bui et al., 2017). Future research could test this idea by modifying static ToM decoding tasks to include contextual cues to increase its ecological validity.

Although worry induces negative mood and has been linked to heightened empathy in GAD (e.g., Peasley et al., 1994), it had no differential impact on affective-reasoning ToM in persons with and without GAD. In GAD, endorsing heightened empathy, care, and affiliation for others on self-reports (cf. interpersonal reactivity index; Davis, 1983; Erickson et al., 2016, p. 23; Hebert, Dugas, Tulloch, & Holowka, 2014, p. 5; Peasley et al., 1994) or expressing more sadness in response to others' disclosures (Erickson & Newman, 2007, p. 373) did not translate to the predicted superior affective-reasoning ToM on the MASC. However, our findings are consistent with a recent meta-analysis which found intact emotion recognition in GAD (Plana et al., 2014). Similarly, across cultures, worry showed no significant link to comprehension of an array of emotional faces (Baron-Cohen et al., 2001; Cooper et al., 2008; Surcinelli et al., 2006; Yoon et al., 2016). Comparable affective-reasoning ToM among those with and without GAD when worried is also consistent with fMRI studies showing that worry bore no relationship with amygdala activity (Blair et al., 2008), which is reliably linked to affective-reasoning ToM (Abu-Akel & Shamay-Tsoory, 2011). Future fMRI studies could test the foregoing theories by observing whether combined trait GAD and worry predicted stronger cognitive-reasoning ToM network activation compared to controls, while simultaneously showing unperturbed affective-reasoning ToM network activation.

Additionally, why were healthy controls better on affective- and positive-reasoning ToM items when they relaxed as opposed to worried? We interpret these results to suggest that for healthy controls, state relaxation, rather than worry, freed up attentional resources to process more of the emotional aspects of the social interactions in the film. Also, this may be due to the fact that emotion regulation strategies such as relaxation come more naturally to healthy controls than GAD sufferers. Future research may test these hypotheses by including measures of attention, emotion regulation, and discomfort arising from engagement in worry and relaxation within experimental contexts.

Last, why were GAD subjects highly accurate with reasoning about negative social signals when they worried, and controls more correct with positive social stimuli upon relaxing? First, worry intensifies the propensity to focus on potential threats (Williams, Mathews, & Hirsch, 2014), which elicits and sustains negative mood states (Newman, Llera, Erickson, Przeworski, & Castonguay, 2013). Worry activated the neural correlates of ToM cognitive-reasoning (cf. ACC, mPFC; Andreescu et al., 2011; Paulesu et al., 2010) as opposed to affective-reasoning and decoding more sharply in clinical than low GAD. Once triggered, viewing the rich tapestry of signals unfolding as the story plot progressed may have reinforced GAD persons' proclivities to focus on negative material. As brain networks connected to cognitive control were activated during state worry, GAD participants showed superior higher-level ToM analytical abilities (reasoning), and normative surface-level recognition (decoding), for negative items. Therefore, ToM reasoning, but not decoding, for negative material was magnified specifically when state worry interacted with clinical trait GAD. Future neuroimaging studies are needed to test these notions.

Although state worry in GAD enhances accuracy for negative social material, is it necessarily beneficial? Does a hypersensitivity to negative subtle complex social cues confer adaptive benefits in terms of curtailing interpersonal risks or resolving social issues? Superior negative ToM reasoning accuracy in clinical trait GAD during a state of worry parallels the idea of depressive realism, wherein clinically depressed people judge contingencies more precisely than their non-depressed counterparts (Alloy & Abramson, 1979). In the realm of ToM, Wolkenstein, Schönenberg, Schirm, and Hautzinger (2011) found that chronically depressed patients were more accurate than controls on negative social stimuli. However, the upshot of such realism for both GAD and depressed individuals is persistent and maladaptive negative mood states which interfere with everyday interpersonal functioning and diminish quality of life. In GAD, such attentional tendencies toward negativity may contribute to relationship problems in the real world (Newman & Erickson, 2010). Thus, GAD sufferers may benefit from cognitive restructuring strategies which assist them to attend *holistically* to both positive and negative aspects of observed social scenarios (Fonzo et al., 2014).

Several limitations of the study deserve mention. The present sample is limited to non-treatment-seeking college students. Nonetheless, participants underwent a standardized clinical interview to determine whether they met criteria for GAD, with excellent inter-rater agreement. Second, the MASC is a well-validated assessment of ToM reasoning that mimics real-life environments relative to other ToM measures (e.g., eyes test). However, it focused on contrived story narratives and protagonists. The lack of self-reference in the MASC hence restricts the generalizability of the data germane to a person's real life. Future research on ToM in GAD should be extended to clinical populations and use ToM tasks with greater self-relevance and self-reference. Third, our findings are preliminary and warrant replication. Last, it is unclear whether worry or relaxation per se drove the observed effects. We attempted to offset this limitation by comparing all means to normative groups. Our finding that worry led to superior negative ToM reasoning compared to norms whereas relaxation led to normative negative ToM reasoning provides some evidence that worry may be driving this effect in people with GAD. Nonetheless, future studies might also include a neutral induction to clarify. The limitations notwithstanding, our findings offer novel contributions to ToM in GAD, an area of research thus far neglected.

Bibliography

Abu-Akel, A., & Shamay-Tsoory, S. (2011). Neuroanatomical and neurochemical bases of theory of mind. *Neuropsychologia*, *49*, 2971-2984. doi:10.1016/j.neuropsychologia.2011.07.012

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Thousand Oaks, CA: Sage Publications, Inc.

Alloy, L. B., & Abramson, L. Y. (1979). Judgment of contingency in depressed and nondepressed students: Sadder but wiser? *Journal of Experimental Psychology: General*, *108*, 441-485. doi:10.1037/0096-3445.108.4.441

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of mental Disorders (DSM-5)*. Washington, DC: American Psychiatric Association. doi:10.1176/appi.books.9780890425596

Andreescu, C., Sheu, L. K., Tudorascu, D., Gross, J. J., Walker, S., Banihashemi, L., & Aizenstein, H. (2015). Emotion reactivity and regulation in late-life generalized anxiety disorder: Functional connectivity at baseline and post-treatment. *The American Journal of Geriatric Psychiatry*, *23*, 200-214. doi:10.1016/j.jagp.2014.05.003

Andreescu, C., Gross, J. J., Lenze, E., Edelman, K. D., Snyder, S., Tanase, C., & Aizenstein, H. (2011). Altered cerebral blood flow patterns associated with pathologic worry in the elderly. *Depression and Anxiety*, *28*, 202-209. doi:10.1002/da.20799

Ashwin, C., Holas, P., Broadhurst, S., Kokoszka, A., Georgiou, G. A., & Fox, E. (2012). Enhanced anger superiority effect in generalized anxiety disorder and panic disorder. *Journal of Anxiety Disorders*, *26*, 329-336. doi:10.1016/j.janxdis.2011.11.010

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, *133*, 1-24. doi:10.1037/0033-2909.133.1.1

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "reading the mind in the eyes" test revised version: A study with normal adults, and adults with asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry*, *42*, 241-251. doi:10.1111/1469-7610.00715

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory–II.* (2nd ed.). San Antonio, TX: The Psychological Corporation.

Blair, K., Shaywitz, J., Smith, B. W., Rhodes, R., Geraci, M., Jones, M., . . . Pine, D. S. (2008). Response to emotional expressions in generalized social phobia and generalized anxiety disorder: Evidence for separate disorders. *American Journal of Psychiatry*, *165*, 1193-1202. doi:10.1176/appi.ajp.2008.07071060

Borkovec, T. D., & Inz, J. (1990). The nature of worry in generalized anxiety disorder: A predominance of thought activity. *Behaviour Research and Therapy*, *28*, 153-158. doi:10.1016/0005-7967(90)90027-G

Brothers, L., & Ring, B. (1992). A neuroethological framework for the representation of minds. *Journal of Cognitive Neuroscience*, *4*, 107-118. doi:10.1162/jocn.1992.4.2.107

Bui, E., Anderson, E., Goetter, E. M., Campbell, A. A., Fischer, L. E., Barrett, L. F., & Simon, N. M. (2017). Heightened sensitivity to emotional expressions in generalised anxiety disorder, compared to social anxiety disorder, and controls. *Cognition and Emotion*, *31*, 119-126. doi:10.1080/02699931.2015.1087973

Carter, W. R., Johnson, M. C., & Borkovec, T. D. (1986). Worry: An electrocortical analysis. *Advances in Behaviour Research and Therapy*, *8*, 193-204. doi:10.1016/0146-6402(86)90004-4

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*, 155-159. doi:10.1037/0033-2909.112.1.155

Cooper, R. M., Rowe, A. C., & Penton-Voak, I. S. (2008). The role of trait anxiety in the recognition of emotional facial expressions. *Journal of Anxiety Disorders*, *22*, 1120-1127. doi:10.1016/j.janxdis.2007.11.010

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, *44*, 113-126. doi:10.1037/0022-3514.44.1.113

Dziobek, I., Fleck, S., Kalbe, E., Rogers, K., Hassenstab, J., Brand, M., . . . Convit, A. (2006). Introducing MASC: A movie for the assessment of social cognition. *Journal of Autism and Developmental Disorders*, *36*, 623-636. doi:10.1007/s10803-006-0107-0

Erickson, T. M., Newman, M. G., Siebert, E. C., Carlile, J. A., Scarsella, G. M., & Abelson, J. L. (2016). Does worrying mean caring too much? Interpersonal prototypicality of dimensional worry controlling for social anxiety and depressive symptoms. *Behavior Therapy*, *47*, 14-28. doi:10.1016/j.beth.2015.08.003

Erickson, T. M., & Newman, M. G. (2007). Interpersonal and emotional processes in generalized anxiety disorder analogues during social interaction tasks. *Behavior Therapy*, *38*, 364-377. doi:10.1016/j.beth.2006.10.005

Etkin, A., Prater, K. E., Schatzberg, A. F., Menon, V., & Greicius, M. D. (2009). Disrupted amygdalar subregion functional connectivity and evidence of a compensatory network in generalized anxiety disorder. *Archives of General Psychiatry*, *66*, 1361-1372. doi:10.1001/archgenpsychiatry.2009.104

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1997). Structured clinical interview for DSM-IV axis I disorders: American Psychiatric Press Washington, DC.

Fisher, A. J., & Newman, M. G. (2013). Heart rate and autonomic response to stress after experimental induction of worry versus relaxation in healthy, high-worry, and generalized anxiety disorder individuals. *Biological Psychology*, *93*, 65-74. doi:10.1016/j.biopsycho.2013.01.012

Fonzo, G. A., Ramsawh, H. J., Flagan, T. M., Sullivan, S. G., Simmons, A. N., Paulus, M. P., & Stein, M. B. (2014). Cognitive-behavioral therapy for generalized anxiety disorder is associated with attenuation of limbic activation to threat-related facial emotions. *Journal of Affective Disorders*, *169*, 76-85. doi:10.1016/j.jad.2014.07.031

Frewen, P. A., Dozois, D. J. A., Joanisse, M. F., & Neufeld, R. W. J. (2008). Selective attention to threat versus reward: Meta-analysis and neural-network modeling of the dot-probe task. *Clinical Psychology Review*, *28*, 307-337. doi:http://dx.doi.org/10.1016/j.cpr.2007.05.006

Frith, C. D., & Frith, U. (2006). The Neural Basis of Mentalizing. *Neuron*, *50*, 531-534. doi:10.1016/j.neuron.2006.05.001

Fritz, C. O., Morris, P. E., & Richler, J. J. (2012). Effect size estimates: Current use, calculations, and interpretation. *Journal of Experimental Psychology: General*, *141*, 2-18. doi:10.1037/a0024338

Harkness, K. L., Jacobson, J. A., Duong, D., & Sabbagh, M. A. (2010). Mental state decoding in past major depression: Effect of sad versus happy mood induction. *Cognition and Emotion*, *24*, 497-513. doi:10.1080/02699930902750249

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1993). Emotional Contagion. *Current Directions in Psychological Science*, *2*, 96–99. doi:10.1111/1467-8721.ep10770953

Heaton, R. K., Chelune, G. J., Talley, J. L., Kay, G. G., & Curtis, G. (1993). *Wisconsin Card Sorting Test (WCST) manual, revised and expanded.* . Odessa, FL: Psychological Assessment Resources, Inc.

Hebert, E. A., Dugas, M. J., Tulloch, T. G., & Holowka, D. W. (2014). Positive beliefs about worry: A psychometric evaluation of the Why Worry-II. *Personality and Individual Differences*, *56*, 3-8. doi:10.1016/j.paid.2013.08.009

Hezel, D. M., & McNally, R. J. (2014). Theory of mind impairments in social anxiety disorder. *Behavior Therapy*, *45*, 530-540. doi:10.1016/j.beth.2014.02.010

Hirsch, C. R., Hayes, S., & Mathews, A. (2009). Looking on the bright side: Accessing benign meanings reduces worry. *Journal of Abnormal Psychology*, *118*, 44-54. doi:10.1037/a0013473

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology*, *1*, 86-92. doi:10.1027/1614-2241.1.3.86

Mattick, R. P., & Clarke, J. C. (1998). Development and validation of measures of social phobia scrutiny fear and social interaction anxiety. *Behaviour Research and Therapy*, *36*, 455-470. doi:10.1016/S0005-7967(97)10031-6

Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behaviour Research and Therapy*, *28*, 487-495. doi:10.1016/0005-7967(90)90135-6

Mochcovitch, M. D., da Rocha Freire, R. C., Garcia, R. F., & Nardi, A. E. (2014). A systematic review of fMRI studies in generalized anxiety disorder: Evaluating its neural and cognitive basis. *Journal of Affective Disorders*, *167*, 336-342. doi:10.1016/j.jad.2014.06.041

Neter, J., Wasserman, W., & Kutner, M. H. (1990). *Applied linear statistical models, 3rd ed*. Homewood, IL: Richard D. Irwin, Inc.

Newman, M. G., Kachin, K. E., Zuellig, A. R., Constantino, M. J., & Cashman-McGrath, L. (2003). The Social Phobia Diagnostic Questionnaire: Preliminary validation of a new self-report diagnostic measure of social phobia. *Psychological Medicine*, *33*, 623-635. doi:10.1017/S0033291703007669

Newman, M. G., Zuellig, A. R., Kachin, K. E., Constantino, M. J., Przeworski, A., Erickson, T., & Cashman-McGrath, L. (2002). Preliminary reliability and validity of the Generalized Anxiety Disorder Questionnaire-IV: A revised self-report diagnostic measure of generalized anxiety disorder. *Behavior Therapy*, *33*, 215-233. doi:10.1016/S0005-7894(02)80026-0

Newman, M. G., Llera, S. J., Erickson, T. M., Przeworski, A., & Castonguay, L. G. (2013). Worry and generalized anxiety disorder: A review and theoretical synthesis of research on nature, etiology, and treatment. *Annual Review of Clinical Psychology*, *9*, 275-297. doi:10.1146/annurev-clinpsy-050212-185544

Newman, M. G., & Erickson, T. M. (2010). Generalized anxiety disorder. In J. G. Beck (Ed.), *Interpersonal processes in the anxiety disorders: Implications for understanding psychopathology and treatment* (pp. 235-259). Washington, DC: American Psychological Association. doi:10.1037/12084-009

Olatunji, B. O., Ciesielski, B. G., Armstrong, T., & Zald, D. H. (2011). Emotional expressions and visual search efficiency: Specificity and effects of anxiety symptoms. *Emotion*, *11*, 1073-1079. doi:10.1037/a0021785

Paulesu, E., Sambugaro, E., Torti, T., Danelli, L., Ferri, F., Scialfa, G., . . . Sassaroli, S. (2010). Neural correlates of worry in generalized anxiety disorder and in normal controls: A functional MRI study. *Psychological Medicine*, *40*, 117-124. doi:10.1017/S0033291709005649

Peasley, C. E., Molina, S., & Borkovec, T. D. (1994). *Empathy in generalized anxiety disorder*. Paper presented at the 28th annual meeting of the Association for Advancement of Behavior Therapy, San Diego, CA.

Plana, I., Lavoie, M. A., Battaglia, M., & Achim, A. M. (2014). A meta-analysis and scoping review of social cognition performance in social phobia, posttraumatic stress disorder and other anxiety disorders. *Journal of Anxiety Disorders*, *28*, 169-177. doi:10.1016/j.janxdis.2013.09.005

Pratt, P., Tallis, F., & Eysenck, M. (1997). Information-processing, storage characteristics and worry. *Behaviour Research and Therapy*, *35*, 1015-1023. doi:10.1016/S0005-7967(97)00057-0

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences*, *1*, 515-526. doi:10.1017/S0140525X00076512

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Newbury Park, CA: Sage.

Robins, L. N., Wing, J., Wittchen, H. U., Helzer, J. E., Babor, T. F., Burke, J., . . . Towle, L. H. (1988). The Composite International Diagnostic Interview: An epidemiologic instrument suitable for use in conjunction with different diagnostic systems and in different cultures. *Archives of General Psychiatry*, *45*, 1069-1077. doi:10.1001/archpsyc.1988.01800360017003

Sabbagh, M. A. (2004). Understanding orbitofrontal contributions to theory-of-mind reasoning: Implications for autism. *Brain and Cognition*, *55*, 209-219. doi:10.1016/j.bandc.2003.04.002

Samson, D. (2009). Reading other people's mind: Insights from neuropsychology. *Journal of Neuropsychology*, *3*, 3-16. doi:10.1348/174866408X377883

Scharfstein, L., Alfano, C., Beidel, D., & Wong, N. (2011). Children with generalized anxiety disorder do not have peer problems, just fewer friends. *Child Psychiatry and Human Development*, *42*, 712-723. doi:10.1007/s10578-011-0245-2

Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., . . . Dunbar, G. C. (1998). The Mini-International Neuropsychiatric Interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *The Journal of Clinical Psychiatry*, *59*(Suppl. 20), 22-33.

Sheehan, D. V., Lecrubier, Y., Harnett Sheehan, K., Janavs, J., Weiller, E., Keskiner, A., . . . Dunbar, G. C. (1997). The validity of the Mini International Neuropsychiatric Interview (MINI) according to the SCID-P and its reliability. *European Psychiatry*, *12*, 232-241. doi:10.1016/S0924-9338(97)83297-X

Stöber, J., & Bittencourt, J. (1998). Weekly assessment of worry: An adaptation of the Penn State Worry Questionnaire for monitoring changes during treatment. *Behaviour Research and Therapy*, *36*, 645-656. doi:10.1016/S0005-7967(98)00031-X

Surcinelli, P., Codispoti, M., Montebarocci, O., Rossi, N., & Baldaro, B. (2006). Facial emotion recognition in trait anxiety. *Journal of Anxiety Disorders*, *20*, 110-117. doi:10.1016/j.janxdis.2004.11.010

Tallis, F., Eysenck, M. W., & Mathews, A. (1992). A questionnaire for the measurement of nonpathological worry. *Personality and Individual Differences*, *13*, 161-168. doi:10.1016/0191-8869(92)90038-Q

Tibi-Elhanany, Y., & Shamay-Tsoory, S. G. (2011). Social cognition in social anxiety: first evidence for increased empathic abilities. *Israel Journal of Psychiatry and Related Sciences*, *48*, 98-106.

Vellante, M., Baron-Cohen, S., Melis, M., Marrone, M., Petretto, D. R., Masala, C., & Preti, A. (2013). The "Reading the Mind in the Eyes" test: systematic review of psychometric properties and a validation study in Italy. *Cogn Neuropsychiatry*, *18*, 326-354. doi:10.1080/13546805.2012.721728

Wilbertz, G., Brakemeier, E.-L., Zobel, I., Härter, M., & Schramm, E. (2010). Exploring preoperational features in chronic depression. *Journal of Affective Disorders*, *124*, 262-269. doi:10.1016/j.jad.2009.11.021

Williams, M. O., Mathews, A., & Hirsch, C. R. (2014). Verbal worry facilitates attention to threat in high-worriers. *Journal of Behavior Therapy and Experimental Psychiatry*, *45*, 8-14. doi:10.1016/j.jbtep.2013.05.006

Wolkenstein, L., Schönenberg, M., Schirm, E., & Hautzinger, M. (2011). I can see what you feel, but I can't deal with it: Impaired theory of mind in depression. *Journal of Affective Disorders*, *132*, 104-111. doi:10.1016/j.jad.2011.02.010

Yoon, S., Kim, H. S., Kim, J.-I., Lee, S., & Lee, S.-H. (2016). Reading simple and complex facial expressions in patients with major depressive disorder and anxiety disorders. *Psychiatry and Clinical Neurosciences*, *70*, 151-158. doi:10.1111/pcn.12369

Zobel, I., Werden, D., Linster, H., Dykierek, P., Drieling, T., Berger, M., & Schramm, E. (2010). Theory of mind deficits in chronically depressed patients. *Depression and Anxiety*, *27*, 821-828. doi:10.1002/da.20713