



## Attention for emotion associated with hypomanic personality traits: Eye-tracking reveals a positive bias independent of mood



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### ABSTRACT

**Background:** Previous research has identified altered processing of emotional information associated with the bipolar spectrum, but results have been inconsistent. The current study assessed whether hypomanic personality traits, a potential indicator of bipolar risk, are associated with biases in attention to emotional facial stimuli, even after controlling for mood state.

**Methods:** Participants ( $N = 135$ ) completed measures assessing current mood symptoms, positive and negative affect, and hypomanic personality traits. They then completed an eye-tracking task measuring two indices of attention (i.e., mean initial orientation latency, mean total gaze duration) for happy, sad, angry, and neutral facial expressions.

**Results:** Even after controlling for mood state, hypomanic personality traits were associated with a bias for emotion faces as well as a trend towards faster orientation to happy facial expressions.

**Limitations:** Due to relatively low levels of mania in this sample, further work is needed to assess the extent to which these effects exist at clinical levels of depression or mania. Additionally, further work is needed to determine if such a bias represents a risk factor for the development of bipolar disorder.

**Conclusions:** Hypomanic personality traits appear to be associated with differences in early attention for emotional information.

### 1. Introduction

The prevalence and high costs associated with bipolar spectrum disorders underscore the need to better understand the etiology of these conditions (Bostwick & Pankratz, 2000; Goetzl, Hawkins, Ozminkowski, & Wang, 2003; Kleinman et al., 2003; Merikangas et al., 2011). Attentional biases may represent one risk factor for mood disorders, as recent research has implicated biased attentional processes in the development and maintenance of depressive symptoms (e.g. Caseras, Garner, Bradley, & Mogg, 2007; Eizenman et al., 2003; Kellough, Beevers, Ellis, & Wells, 2008). These theories hypothesize that individuals with depression have maladaptive attentional systems biased towards allocating attentional resources towards negatively valenced stimuli (Gotlib & Joormann, 2010). As assessed by eye tracking paradigms, individuals with depressive disorders tend to show a reduced orientation to and maintenance on positive stimuli as well as increased gaze maintenance on dysphoric stimuli (Armstrong & Olatunji, 2012; Duque & Vázquez, 2015). Attentional biases in depression are further characterized by biases on later stages of

attentional processing (Armstrong & Olatunji, 2012).

In contrast to depression, attentional biases in bipolar disorder may be more complex due to vacillations in mood state between highly positive and highly negative moods. Preferential processing of mood-valenced stimuli in attention paradigms frequently depends on a multitude of factors, such as mood state, usage of a mood induction task, and history of illness (García-Blanco, Salmerón, Perea, & Livianos, 2014; García-Blanco, Salmerón, & Perea, 2015; Jongen, Smulders, Ranson, Arts, & Krabbendam, 2007; Leyman, De Raedt, & Koster, 2009; Murphy et al., 1999; Peckham, Johnson, & Gotlib, 2016; Trevisani, Johnson, & Carver, 2008).

Initial research on attentional biases in this area focused on individuals with bipolar disorder in a depressed mood state. These individuals demonstrated greater difficulty with attentional disengagement from all emotional words and images, independent of valence, as well as biases away from positively valenced stimuli when stimuli are presented one at a time (Jongen et al., 2007; Leyman et al., 2009). Further, when happy and threatening images are presented simultaneously, this population preferentially attends to threatening stimuli

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(i.e., angry faces; García-Blanco et al., 2014). Though avoidance of positive stimuli appears to be a consistent finding in individuals who are in depressed phases of bipolar disorder, the extent to which this represents a bipolar-specific trait or is simply due to depressive affect is unclear given similar findings in unipolar individuals in depressed states (Duque & Vázquez, 2015).

In contrast, individuals with bipolar disorder who are currently in a manic state, as well as those who have been primed with positive mood, may show bias towards positive emotional stimuli (Murphy et al., 1999; Trevisani et al., 2008), although not all studies have shown this (Peckham et al., 2016). Finally, attention to threatening images is elevated in individuals with bipolar disorder, regardless of mood state (García-Blanco et al., 2014, 2015), suggesting that bias towards threatening stimuli may represent a vulnerability marker in bipolar disorder.

Attentional bias has also been investigated in those considered to be at risk of developing bipolar disorder. Gotlib, Traill, Montoya, Joormann, and Chang, (2005) found that following a negative mood induction procedure, offspring of individuals with bipolar disorder were more likely to remember negative words in a self-referent encoding task than children of non-disordered parents. Additionally, the former offspring exhibited an attentional bias towards social-threat and manic-irritable words in an emotional Stroop task. Gotlib et al. (2005) suggested that these findings indicate a pathogenic cognitive processing scheme that is activated by negative mood in children with biological predispositions to affective disorders. In contrast, a study of euthymic adolescents with the bipolar phenotype demonstrated enhanced processing of surprised and neutral expressions, but not happy, fearful, disgusted, or angry faces, in a facial expression recognition task (Rock, Goodwin, & Harmer, 2010). These adolescents remembered positive and negative personality trait words presented for emotional categorization equally well but exhibited decreased latency in identifying the positive words in a recognition task. The study's authors suggested these findings indicate that bipolar-vulnerable adolescents have a bias toward enhanced processing of positive information. Although these studies share certain limitations, including small samples and unreliable methods of assessing attentional biases, the divergent findings of Gotlib et al. (2005) and Rock et al. (2010) suggest current affect may have important effects on the pattern of information processing in bipolar-vulnerable individuals.

Understanding influences of early attentional processes and later cognitive processes may help provide insights into the etiology and progression of bipolar disorder. Cognitive theories have suggested that over time, individuals with bipolar disorder learn to avoid excessive activation states in an effort to prevent the development of manic episodes (Mansell, Morrison, Reid, Lowens, & Tai, 2007). These theories may help clarify the diversity in study findings regarding early attention in bipolar disorder. One potential hypothesis is that attentional systems are differentially affected based on progression of disease state. In early phases or risk states, positive mood-avoidance strategies may not have developed. In contrast, later phases of the illness (i.e., after bipolar disorder has been identified and formally diagnosed) may be marked by compensatory strategies designed to avoid positive stimuli.

Given this background, the degree to which bipolar vulnerability is related to trait-like biases in attention for emotional information remains unclear. Therefore, the present study sought to assess the relationship between hypomanic personality traits and attention biases toward emotionally-valenced stimuli. Previous studies largely relied on dot-probe tasks, which have consistently demonstrated low reliability (Schmukle, 2005; Staugaard, 2009; Waechter, Nelson, Wright, Hyatt, & Oakman, 2014). In contrast, the current study relied on a more sensitive measure (i.e., eye-tracking) to assess attention to happy, sad, angry, and neutral faces. Eye-tracking provides a direct measurement of eye gaze patterns and demonstrates high reliability for attention across longer periods (Waechter et al., 2014). Study hypotheses were that higher levels of hypomanic traits would be associated with a bias for attending

more quickly and for longer periods of time to positively-valenced stimuli. However, we also hypothesized that current mood state would moderate this effect, with hypomanic traits leading to greater attention to negatively-valenced stimuli among individuals with more depressed mood.

## 2. Method

### 2.1. Participants

Participants ( $N = 135$ ) were young adults (58.50% female, 41.50% male,  $M_{age} = 20.16$ ,  $SD_{age} = 2.00$ ) recruited from introductory classes at a large public university in the southern United States. Regarding race and ethnicity, 60.70% self-identified as white, 23.00% as African American, 16.30% as Hispanic, 7.40% as Asian, and 0.70% as Native American or Alaskan Native. Participants were excluded based on two eye-tracking criteria (i.e., unable to calibrate to gaze, less than 30% of gaze capture). No other inclusion or exclusion criteria were used.

### 2.2. Procedures

Participants met individually with a research assistant who obtained written, informed consent prior to administering self-report measures. After completing the questionnaires, participants completed a computer-based eye-tracking task measuring attention allocation. The university's institutional review board approved all procedures. Research was conducted in accordance with the Helsinki Declaration as revised 1989.

### 2.3. Measures

#### 2.3.1. Hypomanic Personality Scale

Hypomanic personality traits were assessed with the Hypomanic Personality Scale (HPS; Eckblad & Chapman, 1986), a self-report measure designed to identify individuals at risk of developing manic or hypomanic episodes. The HPS consists of 48 statements rated "true" or "false" by the respondent. The measure was developed to identify premonitory hypomanic personality characteristics. In the present sample, the HPS demonstrated adequate internal consistency (Cronbach's  $\alpha = 0.78$ ), and six participants (4% of sample) scored above 36 on the HPS, the cutoff for high risk (Kwapil et al., 2000). The mean HPS score was 19.59 ( $SD = 9.14$ ), with a range from 1 to 40 (of a possible 1–48).

#### 2.3.2. Positive and Negative Affect Schedule

The Positive and Negative Affect Schedule (PANAS) is a 20-item self-report measure created by Watson, Clark, and Tellegen (1988) for the assessment of positive and negative affect. Confirmatory factor analysis of the PANAS has supported its construct validity, and the measure has exhibited satisfactory internal consistency reliability for both the positive affect (PA) scale (Cronbach's  $\alpha = 0.89$ ) and the negative affect (NA) scale (Cronbach's  $\alpha = 0.85$ ; Crawford & Henry, 2004). Both the PA and NA scales demonstrated adequate internal consistency in the present sample (Cronbach's  $\alpha = 0.93$  and 0.81, respectively).

#### 2.3.3. Inventory of Depression and Anxiety Symptoms – II

The Inventory of Depression and Anxiety Symptoms – II (IDAS-II) is a 99-item self-report measure of symptoms of anxiety, depression, bipolar disorder, and PTSD. Developed by Watson et al. (2007, 2012), it has been shown to have strong psychometric properties, including excellent convergent and discriminant validity for its symptom scales (Watson et al., 2012). In the present study, the General Depression scale was used to assess for current depression. Two IDAS-II scales assessing manic symptoms (i.e., euphoria, activation, flight of ideas, increased speech) were combined to create a Mania Composite scale. In the

current sample, the General Depression scale demonstrated adequate internal consistency (Cronbach's  $\alpha = 0.89$ ), as did the Mania Composite scale (Cronbach's  $\alpha = 0.81$ ).

#### 2.3.4. Attention for emotional information

Attention for emotional information (i.e., initial orientation latency, gaze duration) was assessed through an eye-tracking task that involved 36 trials, each of which had participants simultaneously view four images of facial affect (i.e., happy, angry, sad, neutral) on a computer screen. Prior to starting the study procedure, participants were informed that there would be a series of images consisting of different facial expressions shown on the screen and that their attention to the images would be tracked using eye-tracking equipment. Participants were instructed to view the images freely, in any way that they pleased. Images of facial affect were drawn from the Radboud faces database, an experimentally validated database of facial images created for research on cognition and emotion (Langner et al., 2010). The emotional expressions exhibited by each of the actors in the database were based on prototypes drawn from the *Investigator's Guide to the Facial Action Coding System* (Ekman, Friesen, & Hager, 2002), a manual with detailed categorization of facial expressions based on the muscle groups used to produce each expression. In each trial, the four faces were of the same actor. Across trials, 39 different actors were used (36 test trials and 3 practice trials). All actors were white, and both male and female faces were used (19 female, 20 male).<sup>1</sup>

For each trial, participants viewed a central fixation cross on a black screen for a one-second duration, followed by the stimulus presentation consisting of one neutral, one sad, one angry, and one positive face, each located in a different quadrant of the screen. Images remained on the screen for 10 s. Image locations randomly varied from trial to trial, so that images of each emotional face category appeared with equal probability in each of the four locations over the course of the task. Probability of stimuli location was equivalent for each participant.

While viewing these images, the location and duration of participants' gaze were measured using the Tobii x50 eye tracker. The Tobii uses near-infrared illuminators to create reflection patterns on the cornea of an individual's eye, which are used to create an image of the eye. This resulting image is used to detect the exact position of the individual's pupil and to process the reflections from the illuminators, determining their exact location. Participants were seated with their faces approximately 24 in. from the computer screen. Prior to stimulus presentation, the Tobii x50 was calibrated to each participant's gaze. Calibration was conducted by having the participant look at five successively presented calibration dots on the screen while images of the eyes were collected and examined. If the software failed to adequately calibrate to the participant's gaze after two attempts, the participant was excluded from further participation in the study.

Two primary outcomes were calculated for the eye-tracking data: mean total gaze duration and mean initial orientation latency. Mean total gaze duration was defined as the average (across slides) of the summed length of fixation time on each stimulus of a particular valence for each trial. Across trials, the mean gaze duration was  $> 8.5$  s. Initial orientation latency was defined as the amount of time between the onset of a visual stimulus and the first fixation on that stimulus. Fixations were defined using Tobii Studio's default fixation filters setting, which determines fixations based upon eye movement velocity. Drifts were considered to be a segment of the signal with slowly changing mean value and were classified as one fixation. Any abrupt change in the signal was classified as a new fixation due to the eyes having moved to another location. Regarding blinks and looking away, a max gap length of 75 ms was used and data was filled-in in these gap

lengths through linear interpolation conducted for each eye separately. To control for individual differences in speed of visual orientation and average gaze duration, scores for neutral faces on both outcomes were used as controls in statistical analyses of respective outcomes for emotional faces.

#### 2.4. Data analysis

Data were first screened to test for outliers and assumptions, with transformations conducted as needed. Next, overall attention patterns (i.e., initial orientation latency, mean total gaze duration) for the different valenced stimuli in the sample were assessed (regardless of HPS scores) and reported by conducting repeated measures ANOVAs on outcomes as a function of valence.

We then tested whether mood state was affecting these outcomes. Semipartial correlations between attention (i.e., mean initial orientation latency, mean total gaze duration) and mood/ affect were estimated through use of multiple regression, with attention to neutral faces controlled for in these analyses.

Primary hypotheses were then tested by estimating semipartial correlations (estimated with multiple regression) between hypomanic personality traits (i.e. HPS scores) and each of the attention outcomes for each emotion face, controlling for the same outcome with respect to neutral faces. In this way, each semipartial is estimating whether there is a bias for the emotion face on that outcome *relative to neutral faces*. These analyses were repeated for each emotion category and each attention outcome (i.e., initial orientation, gaze duration). For example, to assess association of HPS to biases for initial orientation to happy faces, we entered the latter as the outcome. Next, initial orientation to neutral faces were entered into the model. Finally, HPS scores were entered last. The semipartial correlation was estimated from the last part of the model and captures the correlation between HPS scores and initial orientation to happy faces, controlling for initial orientation to neutral faces. Finally, additional analyses were conducted to allow for the direct comparison of HPS and face valence. Specifically, repeated measures ANOVAs were conducted to examine the relationship between HPS and visual attention.

Analyses for the primary hypotheses were repeated to ensure effects were not due to subsyndromal symptoms. Specifically, in addition to testing the association while controlling for 1) attention to neutral faces as described above, we also tested the association after controlling for 2) attention to neutral faces, mania symptoms, and depression symptoms, and 3) attention to neutral faces, mania symptoms, depression symptoms, positive affect, and negative affect.

Finally, exploratory analyses were conducted to test whether HPS scores were interacting with depressed mood state to affect attention. Analyses for the primary hypotheses were repeated, but interaction effects between HPS and depressed mood were also entered into the models.

### 3. Results

Prior to conducting primary analyses, data for the attention outcomes were calculated and cleaned, and scores on all variables were screened for univariate and multivariate outliers, normality, and other primary test assumptions. Originally, 154 participants were recruited; however, 19 individuals were excluded from analyses due to insufficient (i.e.,  $< 30\%$ ) gaze capture on the eye-tracking task. This resulted in the final sample of 135 participants upon which results were based. Negative affect scores were transformed (natural log) to improve their skew and kurtosis. Split half reliability analyses for each facial emotion type were conducted on the eye-tracking task to ensure observed effects were not due to chance. The Spearman-Brown coefficients ranged from 0.73 to 0.86, with all but three conditions (i.e., orientation to happy faces, gaze duration to neutral faces, gaze duration to sad faces) having reliability over 0.80. Descriptive statistics for all

<sup>1</sup> The specific Radboud faces were Rafd090\_01, Rafd090\_02, 03, 04, 05, 07, 08, 09, 10, 12, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 32, 33, 36, 37, 38, 46, 47, 49, 56, 57, 58, 61, 71.

**Table 1**  
Descriptive Statistics for Mean Initial Orientation Latency (MIOL), Mean Total Gaze Duration (MTGD), Hypomanic Personality Scale, Inventory of Depression and Anxiety Symptoms – II (IDAS-II), and Positive and Negative Affect Schedule (PANAS).

Item	Category	M	SD
MIOL	Angry	1.74	0.56
	Happy	1.65	0.57
	Sad	1.73	0.59
	Neutral	1.74	0.56
MTGD	Angry	1.91	0.45
	Happy	2.50	0.76
	Sad	1.96	0.44
	Neutral	2.11	0.49
HPS	Total	19.59	9.14
IDAS-II	Mania Composite	9.78	4.33
	General Depression	41.73	12.34
PANAS	Positive Affect	17.43	7.34
	Negative Affect	12.56	4.11

MIOL and MTGD values reported in seconds.

measures are reported in Table 1.

Overall, participants were generally characterized by a positive information processing bias for both time to fixation,  $F(3, 402) = 4.10$ ,  $p < 0.01$ , and gaze duration,  $F(3, 402) = 40.61$ ,  $p < 0.001$ . Individuals generally oriented more quickly to happy faces ( $M = 1647$  ms,  $SD = 574$ ) relative to angry ( $M = 1745$  ms,  $SD = 559$ ,  $p < 0.01$ ) and sad faces ( $M = 1729$  ms,  $SD = 589$ ,  $p = 0.05$ ). There were no significant differences between angry, sad, and neutral faces or between happy and neutral faces ( $p$ 's  $> 0.05$ ). Participants also gazed for longer at happy faces ( $M = 2498$  ms,  $SD = 757$ ) relative to angry ( $M = 1914$  ms,  $SD = 454$ ,  $p < 0.01$ ), sad ( $M = 1958$  ms,  $SD = 437$ ,  $p < 0.01$ ), or neutral ones ( $M = 2113$  ms,  $SD = 490$ ,  $p < 0.01$ ). Individuals gazed at neutral faces longer than angry ( $p < 0.01$ ) and sad faces ( $p < 0.01$ ). As presented in Table 2, attention outcomes for emotional faces were not significantly correlated with measures of mood or affect when controlling for attention to neutral faces.

Primary hypotheses were next tested using semipartial correlation coefficients. Consistent with hypotheses, HPS scores were significantly associated with shorter latency to fixate on happy facial expressions (column 1 of Table 3). This remained true even after controlling for affect and mood state (columns 2 and 3 of Table 3). Effects were small (semipartial  $r^2 < 0.20$ ). Moreover, effects were apparent only for initial orientation latency, not for duration of visual attention. Similar trends were also observed for latency of initial orientation to angry and sad faces but did not reach significance.

Primary hypotheses were also examined using repeated measures ANOVAs to control for dependencies among the attention outcomes to emotion expressions. For gaze duration, the findings from the

**Table 2**  
Correlations between Current Mood Symptoms and Attention Outcomes.

	Bipolar Scales					
	General Depression	Euphoria	Mania	Mania Composite	Positive Affect	Negative Affect
<b>Angry Faces</b>						
Mean Initial Orientation Latency <sup>a</sup>	0.11	-0.06	-0.05	0.07	-0.00	-0.00
Mean Total Gaze Duration <sup>b</sup>	-0.11	-0.03	-0.04	-0.10	-0.03	0.00
<b>Happy Faces</b>						
Mean Initial Orientation Latency <sup>a</sup>	0.04	0.03	-0.02	0.03	-0.00	-0.11
Mean Total Gaze Duration <sup>b</sup>	-0.02	0.11	-0.01	-0.02	0.00	0.17
<b>Sad Faces</b>						
Mean Initial Orientation Latency <sup>a</sup>	-0.03	0.09	-0.02	-0.03	0.03	-0.12
Mean Total Gaze Duration <sup>b</sup>	0.00	-0.11	0.03	-0.01	-0.05	0.01

<sup>a</sup>Significant at  $p < 0.05$ .

<sup>a</sup> Mean initial orientation latency on neutral faces was controlled for each correlation.

<sup>b</sup> Mean total gaze duration for neutral faces was controlled for each correlation.

**Table 3**  
Correlations between Hypomanic Personality Traits and Eye-Tracking Attention Outcomes.

	HPS Score		
	1	2	3
<b>Angry Faces</b>			
Mean Initial Orientation Latency	-0.16	-0.13	-0.14
Mean Total Gaze Duration	-0.01	0.00	0.01
<b>Happy Faces</b>			
Mean Initial Orientation Latency	-0.17*	-0.18*	-0.19*
Mean Total Gaze Duration	0.03	0.06	0.10
<b>Sad Faces</b>			
Mean Initial Orientation Latency	-0.11	-0.11	-0.12
Mean Total Gaze Duration	-0.04	-0.03	-0.03

<sup>1</sup>Controlling for attention to neutral faces.

<sup>2</sup>Controlling for attention to neutral faces, IDAS-II Mania Composite and IDAS-II General Depression scores.

<sup>3</sup>Controlling for attention to neutral faces, IDAS-II Mania Composite and General Depression scores, and PANAS positive and negative affect scores.

\* Significant at  $p < 0.05$ .

semipartial correlation were replicated, with there being a significant main effect for facial valence when controlling for attention to neutral faces,  $F(1.14, 150.88) = 21.32$ ,  $p < 0.001$ ,  $\eta^2 = 0.14$ . Pairwise comparisons showed that participants gazed significantly longer at happy faces than sad ( $p < 0.001$ ) and angry faces ( $p < 0.001$ ). No significant differences were found between sad and angry faces ( $p = 0.152$ ). No significant main effect for HPS,  $F(1, 132) = 0.07$ ,  $p = 0.788$ ,  $\eta^2 = 0.001$ , or interaction between gaze duration and HPS,  $F(1.14, 150.88) = 0.82$ ,  $p = 0.380$ ,  $\eta^2 = 0.006$ , was found. Regarding time to first fixation, there was no significant main effect for valence when controlling for attention to neutral faces,  $F(2, 264) = 0.378$ ,  $p = 0.686$ ,  $\eta^2 = 0.003$ . The interaction between HPS and time to first fixation was also not significant,  $F(2, 264) = 0.365$ ,  $p = 0.695$ ,  $\eta^2 = 0.003$ . However, the main effect of HPS was significant when controlling for attention to neutral faces,  $F(1, 132) = 5.503$ ,  $p = 0.020$ ,  $\eta^2 = 0.040$ . Additionally, this main effect of HPS remained significant when additional covariates were included (i.e., IDAS-II Mania Composite, General Depression scores, positive affect, negative affect). Results from the second analyses underscore HPS is significantly associated with a bias toward early fixation on emotion faces, although its specificity with respect to happy faces is only a trend.

Next, the moderating role of depressed mood state was examined. Across facial expressions, the interaction between HPS and IDAS-General Depression was not significantly associated with initial orientation latency (Angry: semipartial  $r^2 = 0.03$ ; Happy: semipartial  $r^2 = 0.02$ ; Sad: semipartial  $r^2 = 0.06$ ) or gaze duration (Angry: semipartial  $r^2 = 0.03$ ; Happy: semipartial  $r^2 = 0.09$ ; Sad: semipartial  $r^2 = 0.02$ ).

#### 4. Discussion

Although there is ample literature examining attentional processes in individuals vulnerable to and diagnosed with unipolar depression (e.g., Beevers & Carver, 2003; Joormann, Talbot, & Gotlib, 2007), similar research into attentional biases associated with risk for bipolar disorder remains relatively sparse and inconclusive. The present study found that hypomanic personality traits, which are considered to be risk markers for development of bipolar disorder, were associated with biased attentional processes. Specifically, these traits were associated with increased initial orientation to emotional stimuli (i.e., facial expressions in this study), with some evidence suggesting a bias towards faster orientation to positive stimuli. Although effects were small, even slight differences in attention processes, in which we continuously engage, may have a cumulatively major impact on clinical phenomena.

These findings are consistent with at least one study (Leyman et al., 2009) suggesting that risk for bipolar disorder is associated with altered processing during the early stages of information-processing. Furthermore, the correlation between HPS scores and speeded orientation to happy faces concurs with a hypothesized positive attention bias in non-disordered individuals with the bipolar phenotype (Rock et al., 2010). The current results indicated a non-significant trend toward faster initial orientation to threatening (i.e., angry) faces, which may be supportive of previous findings of attentional biases towards threatening images and social-threat words (García-Blanco et al., 2014, 2015; Gotlib et al., 2005).

Of note, there was no apparent bias for indices of more sustained attention to emotion faces. This finding suggests that vulnerability to bipolar disorder may be associated with differences only in initial orientation of visual attention. The significant correlation between hypomanic traits and faster orientation of attention to happy faces was found even after controlling for symptoms of depression and mania, as well as current affective state, suggesting it may be a trait-like indicator.

The current study did not support the hypothesis that bipolar disorder vulnerability, as indexed by hypomanic personality traits, is associated with negative information processing biases that are activated by negative mood. That is, depression symptoms did not interact with self-reported hypomanic personality traits to produce biased attention for sad faces. This finding is in contrast to the findings of Gotlib et al. (2005). However, study limitations warrant caution in interpreting this null effect. Levels of depression in the present sample were low, which may have limited power to detect this type of moderation. Further research of this interaction within a selected sample of individuals with elevated depressive symptoms is needed.

The present study has a number of strengths. It improved upon previous studies examining cognitive biases by utilizing eye-tracking, a more sensitive measure of visual attention than previously used designs (e.g., dot-probe). Additionally, this study utilized a continuous measure of risk rather than the dichotomous grouping of “at-risk” and “not at-risk” that was utilized in previous research (e.g., Rock et al., 2010). Nevertheless, findings should be interpreted in light of limitations. Foremost among them is that the incidence of hypomanic personality traits, as well as manic and depressive symptoms, was low in the present sample. The extent to which these effects are more or less pronounced at clinical levels of depression or mania must be independently tested. Moreover, whether these effects reflect a process specific to hypomanic personality style versus one that generalizes to clinical samples of individuals with bipolar disorder remains to be tested. Further, the sample consisted of a somewhat homogeneous sample of young university students, which may limit the generalizability of the results. Finally, given the small effects found in the present study and the possibility that they resulted from sampling error, the results should be interpreted with caution and as preliminary until they are replicated in other studies.

Despite these limitations, the present study underscores that biases in attention for emotional information may be associated with hypomanic personality traits. Individuals with high levels of hypomanic personality traits are at heightened risk of manic episodes (Kwapil et al., 2000) and have been shown to have higher consumption of alcohol and nicotine than low-scoring counterparts (Krumm-Merabet & Meyer, 2005). Attentional biases may represent mechanisms by which a cognitive vulnerability toward engagement with rewarding stimuli is expressed in pleasure-seeking behaviours. As such, a potential bias in initial orientation of attention toward rewarding stimuli in the form of positive social stimuli (Niedenthal, Mermillod, Maringer, & Hess, 2010) may have important clinical implications. Future work exploring the prospective relationship between attention processing and the development of episodes of mania or depression remains an important area for research.

#### Author Contributors

Allison Dornbach-Bender was involved in statistical analysis and manuscript preparation.

Camilo J. Ruggero was involved in the study design, data collection, statistical analysis and manuscript preparation.

Kathleen M. Bain was involved in study design, data collection, statistical analysis, and manuscript preparation.

Patrick Smith was involved in manuscript preparation.

Keke L. Schuler was involved in statistical analysis and manuscript preparation.

Jesse M. Smotherman was involved in manuscript preparation.

Jennifer L. Callahan was involved in study design and manuscript preparation.

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