

Appendix 1 to Kim P, Arizpe K, Rosen B, et al. Impaired fixation on eyes during facial emotion labelling in children with bipolar disorder or severe mood dysregulation. *J Psychiatry Neurosci* 2013

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Emotion recognition accuracy

In addition to the group main effect, there was a main effect of emotion in both the 3-way and 2-way 100%-level omnibus analyses of covariance (ANCOVA; Table S1). Specifically, across morphed emotional levels, accuracy increased from sad (mean 48.70%, standard deviation [SD] 16.41), to angry (mean 60.28%, SD 14.44), to neutral (mean 74.31%, SD 21.48), to fearful (mean 78.61%, SD 14.47), to happy (mean 86.53%, SD 11.66) expressions. Regarding accuracy, each emotion differed from each of the other emotions, except that the difference between fearful and neutral expressions was at a trend level (all $t_{71} > 1.95$, all $p < 0.10$).

In the 3-way omnibus ANCOVA, there was also a main effect of morphed emotional level (Table S1); across emotions, accuracy was lowest for 60% (mean 55.56%, SD 10.99), higher for 80% (mean 71.49%, SD 11.97), and highest for 100% (mean 77.69%, SD 10.37) expressions (all $t_{71} > 6.12$, all $p < 0.001$).

Accuracy was compared with 2 omnibus analyses: 1) 3-way repeated-measures ANCOVA with group (bipolar disorder [BD], severe mood dysregulation [SMD], healthy control) as a between-subjects factor and emotion (anger, fear, sadness, happiness) and emotional level (60%, 80%, 100%) as within-subjects factors and 2) 2-way repeated-measures ANCOVA with group (BD, SMD, control) as a between-subjects factor and emotion (100% emotional expression of anger, fear, sadness, happiness, neutral) as a within-subjects factor. Age was included as a covariate for all analyses.

Table S1: ANCOVA for behavioural emotion labelling accuracy

Model	Test	<i>p</i> value
3-way omnibus		
Group	$F_{2,68} = 3.81$	*
Emotion	$F_{3,204} = 7.53$	***
Emotional level	$F_{2,136} = 3.23$	*
2-way interaction		
Group × emotion	$F_{6,204} = 0.96$	
Group × emotional level	$F_{4,136} = 1.38$	
Emotion × emotional level	$F_{6,408} = 1.26$	
3-way interaction		
Group × emotion × emotional level	$F_{12,408} = 0.84$	
Group	$F_{2,68} = 4.54$	*
Emotion	$F_{4,272} = 8.65$	***
2-way interaction		
Group × emotion	$F_{8,272} = 1.25$	

ANCOVA = analysis of covariance.
 *** $p < 0.001$,
 * $p < 0.05$.

Eye movement data

Total fixation durations

In addition to a group \times interest areas \times level interaction, the 4-way omnibus ANCOVA analysis found an emotion \times level interaction (Table S2). When this interaction was decomposed for each emotion, the main effect of emotional level was significant only for sad expressions ($F_{2,142} = 3.96, p < 0.05$); the total fixation durations on 60% and 80% sad expressions were longer than those on 100% sad expressions ($F_{1,71} > 4.16, p < 0.05$). A main effect of interest areas was also significant (Table S2).

In the 3-way 100%-level omnibus ANCOVA, in addition to a group \times interest areas interaction, a main effect of emotion indicated that the total fixation durations of 100% fearful expressions were longer than the total fixation duration of 100% sad expressions ($F_{1,71} = 4.76, p < 0.05$; Table S2).

Table S2. ANCOVA for total fixation durations*

Model	Test	<i>p</i> value
4-way omnibus		
Main effect		
Group	$F_{2,68} = 0.98$	
Interest areas	$F_{4,136} = 3.10$	**
Emotion	$F_{3,204} = 0.88$	
Level	$F_{2,136} = 1.62$	
2-way interaction		
Group \times interest areas	$F_{2,136} = 1.27$	
Group \times emotion	$F_{6,204} = 0.68$	
Group \times level	$F_{4,136} = 1.90$	
Interest areas \times emotion	$F_{6,408} = 0.66$	
Interest areas \times level	$F_{4,272} = 0.86$	
Emotion \times level	$F_{6,408} = 2.77$	**
3-way interaction		
Group \times interest areas \times emotion	$F_{12,408} = 0.92$	
Group \times interest areas \times level	$F_{8,272} = 2.15$	**
Group \times emotion \times level	$F_{12,408} = 1.56$	
Interest areas \times emotion \times level	$F_{12,816} = 0.82$	
4-way interaction		
Group \times interest areas \times emotion \times level	$F_{24,816} = 1.00$	
3-way 100%-level omnibus		
Main effect		
Group	$F_{2,68} = 3.84$	**
Interest areas	$F_{2,136} = 0.86$	
Emotion	$F_{4,272} = 3.00$	**
2-way interaction		
Group \times interest areas	$F_{4,136} = 3.13$	**
Group \times emotion	$F_{8,272} = 1.11$	
Interest areas \times emotion	$F_{6,544} = 0.48$	
3-way interaction		
Group \times interest areas \times emotion	$F_{16,544} = 0.63$	

ANCOVA = analysis of covariance; BD = bipolar disorder; SMD = severe mood dysregulation.

*Total fixation durations were compared with 2 omnibus analyses: 4-way repeated-measure ANCOVA with group (BD, SMD, control) as a between-subjects factor and emotion (anger, fear, sadness, happiness), emotional level (60%, 80%, 100%), and interest areas (eyes, nose, mouth) as within-subjects factors, and 3-way repeated-measures ANCOVA including group (BD, SMD, control) as a between-subjects factor and emotion (100% emotional expression of anger, fear, sadness, happiness, neutral), and interest areas (eyes, nose, mouth) as within-subjects factors. Age was included as a covariate for all analyses.

** $p < 0.05$.

Number of fixations

In the 4-way omnibus ANCOVA, in addition to a group \times interest areas \times emotion interaction, a group \times interest areas interaction, a main effect of group and a main effect of emotional level were significant (Table S3). The main effect of emotional level indicates that participants made more fixations to 60% than 80% or 100% expressions ($t_{71} > 4.09, p < 0.001$).

In the 3-way 100%-level omnibus ANCOVA analysis, in addition to a group \times interest areas interaction, a main effect of group was significant (Table S3).

Table S3. ANCOVA for number of fixations*

Model	Test	<i>p</i> value
4-way omnibus		
Main effect		
Group	$F_{2,68} = 4.26$	**
Interest areas	$F_{2,136} = 0.67$	
Emotion	$F_{3,204} = 0.42$	
Level	$F_{2,136} = 4.08$	**
2-way interaction		
Group \times interest areas	$F_{4,136} = 3.63$	***
Group \times emotion	$F_{6,204} = 1.34$	
Group \times level	$F_{4,136} = 1.32$	
Interest areas \times emotion	$F_{6,408} = 0.23$	
Interest areas \times level	$F_{4,272} = 0.65$	
Emotion \times level	$F_{6,408} = 1.26$	
3-way interaction		
Group \times interest areas \times emotion	$F_{12,408} = 2.11$	**
Group \times interest areas \times level	$F_{8,272} = 0.78$	
Group \times emotion \times level	$F_{12,408} = 1.00$	
Interest areas \times emotion \times level	$F_{12,816} = 1.01$	
4-way interaction		
Group \times interest areas \times emotion \times level	$F_{24,816} = 0.71$	
3-way 100%-level omnibus		
Main effect		
Group	$F_{2,68} = 4.76$	**
Interest areas	$F_{2,136} = 0.38$	
Emotion	$F_{4,272} = 1.31$	
2-way interaction		
Group \times interest areas	$F_{4,136} = 3.66$	***
Group \times emotion	$F_{8,272} = 0.62$	
Interest areas \times emotion	$F_{8,544} = 0.66$	
3-way interaction		
Group \times interest areas \times emotion	$F_{16,544} = 1.19$	

ANCOVA = analysis of covariance; BD = bipolar disorder; SMD = severe mood dysregulation.

*Number of fixations were compared with 2 omnibus analyses: 4-way repeated-measures ANCOVA with group (BD, SMD, control) as a between-subjects factor, and emotion (anger, fear, sadness, happiness), emotional level (60%, 80%, 100%), and interest areas (eyes, nose, mouth) as within-subjects factors, and 3-way repeated-measures ANCOVA including group (BD, SMD, control) as a between-subjects factor and emotion (100% emotional expression of anger, fear, sadness, happiness, neutral), and interest areas (eyes, nose, mouth) as within-subjects factors. Age was included as a covariate for all analyses.

** $p < 0.05$.

*** $p < 0.01$.

Mean fixation durations

A main effect of interest areas was found in the 4-way omnibus and 3-way 100%-level omnibus analyses (Table S4). Post hoc analyses revealed that across expressions, eye fixations were longer than nose or mouth fixations ($F_{1,71} > 98.89, p < 0.001$). No other effects were found (Table S4).

Table S4. ANCOVA for mean fixation durations*

Model	Test	<i>p</i> value
4-way omnibus		
Main effect		
Group	$F_{2,61} = 2.77$	
Interest areas	$F_{2,122} = 3.62$	**
Emotion	$F_{3,183} = 0.59$	
Level	$F_{2,122} = 0.98$	
2-way interaction		
Group × interest areas	$F_{4,122} = 1.06$	
Group × emotion	$F_{6,183} = 0.31$	
Group × level	$F_{4,122} = 1.32$	
Interest areas × emotion	$F_{6,366} = 1.56$	
Interest areas × level	$F_{4,244} = 0.85$	
Emotion × level	$F_{6,366} = 0.57$	
3-way interaction		
Group × interest areas × emotion	$F_{12,366} = 0.77$	
Group × interest areas × level	$F_{8,244} = 1.32$	
Group × emotion × level	$F_{12,366} = 1.70$	
Interest areas × emotion × level	$F_{12,732} = 1.29$	
4-way interaction		
Group × interest areas × emotion × level	$F_{24,732} = 1.37$	
3-way 100%-level omnibus		
Main effect		
Group	$F_{2,61} = 2.03$	
Interest areas	$F_{2,122} = 3.47$	**
Emotion	$F_{4,244} = 0.86$	
2-way interaction		
Group × interest areas	$F_{4,122} = 2.17$	
Group × emotion	$F_{8,244} = 1.30$	
IA × emotion	$F_{8,488} = 1.22$	
3-way interaction		
Group × interest areas × emotion	$F_{16,488} = 0.74$	

ANCOVA = analysis of covariance; BD = bipolar disorder; SMD = severe mood dysregulation.

*Mean fixation durations were compared with 2 omnibus analyses: 4-way repeated-measures ANCOVA with group (BD, SMD, control) as a between-subjects factor, and emotion (anger, fear, sadness, happiness), emotional level (60%, 80%, 100%), and interest areas (eyes, nose, mouth) as within-subjects factors, and 3-way repeated-measures ANCOVA including group (BD, SMD, control) as a between-subjects factor and emotion (100% emotional expression of anger, fear, sadness, happiness, neutral), and interest areas (eyes, nose, mouth) as within-subjects factors. Age was included as a covariate for all analyses.

** $p < .05$.

Effects of comorbid illnesses, mood state or medications

Post hoc exploratory analyses examined whether gaze pattern differences between children with BD and healthy controls could be driven by comorbid illnesses, mood state or medications. The main analyses, described in the main manuscript, revealed that children with BD spent less time fixating on eyes at all intensities and made fewer eye fixations for all emotions ($p < 0.05$). For 80% morphed emotional expressions, children with BD also made longer nose fixations than controls ($p < 0.05$). First, to examine the effects of comorbid illnesses in children with BD, we

compared 1) children with BD without comorbid anxiety disorders ($n = 8$) versus controls; 2) children with BD without oppositional defiant disorder (ODD) or other conduct disorders ($n = 16$) versus controls; and 3) children with BD without attention-deficit/hyperactivity disorder (ADHD; $n = 7$) versus controls. The differences between the subgroups of BD and controls were found for most analyses ($F > 3.19, p < 0.10$). Two exceptions were that children with BD without ADHD did not differ from controls in the number of eye fixations for neutral or happy expressions. Second, to test the effects of mood state, euthymic children with BD ($n = 16$) were compared with controls; euthymic children with BD differed from controls on all analyses ($F_{1,35} > 6.89, p < 0.05$). Third, since the number of unmedicated children with was very small ($n = 3$), we could not compare them to controls.

Children with SMD spent less time than controls fixating on the eyes of 80% emotional expressions ($p < 0.05$), so the effects of medication and comorbid illnesses on this finding were also tested. To examine the effects of comorbid illnesses, we compared 1) children with SMD without comorbid anxiety disorders ($n = 11$) versus controls; 2) children with SMD without ODD or other conduct disorders ($n = 12$) versus controls; and 3) children with SMD without ADHD ($n = 6$) versus controls. The subgroups of children with SMD did not differ from controls in all tests. Second, to test the effects of medication, unmedicated children with SMD ($n = 9$) was compared with controls; unmedicated children with SMD differed from controls on all analyses ($F_{1,29} = 7.73, p < 0.05$).