ISSN 2220-3206 (online)

World Journal of *Psychiatry*

World J Psychiatr 2021 September 19; 11(9): 507-680

Published by Baishideng Publishing Group Inc

WJP World Journal of Psychiatry

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Monthly Volume 11 Number 9 September 19, 2021

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NAME OF JOURNAL
World Journal of Psychiatry

ISSN
ISSN 2220-3206 (online)

LAUNCH DATE
December 31, 2011

FREQUENCY
Monthly

EDITORS-IN-CHIEF
Rajesh R Tampi

EDITORIAL BOARD MEMBERS
https://www.wjgnet.com/2220-3206/editorialboard.htm

PUBLICATION DATE
September 19, 2021

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World J Psychiatr 2021 September 19; 11(9): 619-634

DOI: 10.5498/wjp.v11.i9.619

ISSN 2220-3206 (online)

ORIGINAL ARTICLE

Observational Study

Evaluating the emotion regulation of positive mood states among people with bipolar disorder using hierarchical clustering

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Author contributions: Chan SHW conceived and guided the study; Liu KHK, Lau C and Fung AOY completed the literature search; Liu KHK, Lau C and Fung AOY coordinated the data collection; Chan SHW and Yu CH performed the statistical analyses; Chan SHW and Tse S wrote and revised the paper; all authors approved the final version of the manuscript.

Institutional review board statement: The study was conducted according to the Declaration of Helsinki and the ethical guidelines established by the University of Hong Kong/West Cluster of the Hong Kong Hospital Authority.

Informed consent statement: All study participants, or their legal guardian, provided informed written consent prior to study enrollment.

Conflict-of-interest statement: The authors declare having no conflicts of interest.

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Abstract

BACKGROUND

People with bipolar disorder (BD) frequently struggle with the recurrence of affective symptoms. However, the interplay between coping mechanism and positive mood state remains under-researched.

AIM

To explore the associations among behavioral approach system (BAS) sensitivity level, coping, and positive mood states among people with BD.

METHODS

Using a cross-sectional study design, 90 participants with BD were presented with four BAS-activating life event scenarios and assessed with regard to their BAS trait sensitivity, coping flexibility, and mood states. A hierarchical clustering method was used to identify different groups with different styles of coping. Multiple hierarchical regression analyses were conducted to examine the mediating and moderating roles of different components of coping on mood states.

RESULTS

A three-cluster solution was found to best fit the present data set. The findings showed that a low mass of coping combined with low BAS sensitivity level protects people with BD from detrimentally accentuating mood states when they encounter BAS-activating life events. Moreover, coping flexibility is demonstrated to mediate and moderate the relationships between BAS sensitivity level and

Data sharing statement: Technical appendix, statistical code, and dataset available from the corresponding author. Participants gave informed consent for data sharing in which the presented data are anonymized and risk of identification is low.

STROBE statement: The authors have read the STROBE Statement-checklist of items, and the manuscript was prepared and revised according to the STROBE Statement-checklist of items.

Manuscript source: Invited manuscript

Specialty type: Psychiatry

Country/Territory of origin: China

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): B
Grade C (Good): 0
Grade D (Fair): 0
Grade E (Poor): 0

Received: March 11, 2021
Peer-review started: March 11, 2021
First decision: July 15, 2021
Revised: July 25, 2021
Accepted: August 18, 2021
Article in press: August, 18, 2021
Published online: September 19, 2021

P-Reviewer: Gazdag G
S-Editor: Gao CC
L-Editor: A
P-Editor: Wang LYT

mood states. Specifically, subduing the perceived controllability and reducing the use of behavioral-activation/emotion-amplifying coping strategies could help buffer the effect of positive affect.

CONCLUSION

The judicious use of coping in emotion regulation for people with BD when encountering BAS-activating life events was indicated. Practical applications and theoretical implications are highlighted.

Key Words: Bipolar disorder; Mood regulation; Cluster analysis; Coping style; Positive emotions

Core Tip: Individuals with bipolar disorder (BD) essentially fail to regulate their emotions and behavior effectively due to their behavioral approach system (BAS) hypersensitivity. This research, based on the BAS dysregulation theory, explores the dynamic role of coping in emotion regulation for managing positive mood states due to BAS-activating life events. Results show that a low mass of coping combined with low BAS sensitivity level protects people with BD from detrimentally accentuating mood states. Practical applications for the improvement of stress management programs and theoretical implication for the extension of coping frameworks to include positive mood states are highlighted.

Citation: Chan SHW, Yu CH, Liu KHK, Lau C, Fung AOY, Tse S. Evaluating the emotion regulation of positive mood states among people with bipolar disorder using hierarchical clustering. *World J Psychiatr* 2021; 11(9): 619-634
URL: https://www.wjgnet.com/2220-3206/full/v11/i9/619.htm
DOI: https://dx.doi.org/10.5498/wjp.v11.i9.619

INTRODUCTION

Bipolar disorder (BD) is a biologically-based disorder with significant neurobiological underpinnings[1,2]. Nonetheless, the evidence was mixed and independent of the argument for a psychological dimension in explaining the emotion dysregulation of BD[3-5]. One of the fundamental psychobiological features of BD is the behavioral approach system (BAS) sensitivity level[6], which can lay a foundation for understanding the emotion dysregulation in BD. Individuals with high BAS sensitivity levels are significantly more likely to have lifetime BD[7]. In particular, they tend to be over-responsive in relation to reward-relevant environmental cues.

As such, BAS is postulated to be a system that integrates motivational factors, personality traits, and behavioral tendencies entailed in goal-seeking and reward responsiveness (RR)[8]. More specifically, the BAS dysregulation theory[9] proposes that weak regulation of the BAS is involved in the fluctuations between high and low mood that characterize BDs. While the excessive increase in BAS activity leads to manic symptoms, the undue decrease in BAS activity would result in depressive symptoms.

In addition, according to the BAS dysregulation theory, individuals with BD essentially fail to regulate their emotions and behavior effectively due to their BAS hypersensitivity. Specifically, the emotion dysregulation in BD is manifested as excessive variability in BAS activity in response to BAS relevant signals. Thus, BAS is justified as a good measure of emotion dysregulation in which individuals with BD would easily show elevated responses on psychophysiological indices of BAS sensitivity[9-11]. Particularly, BAS hypersensitivity and vulnerability to dysregulation may be an "endophenotype that mediates the effects of the genetic predisposition to bipolar disorder"[12].

Difficulties in achieving positive emotion regulation may contribute to the development of mania in people with BD[13,14]. Thus, exploring strategies in managing positive affects in BD was accordingly called for[15]. Alloy *et al*[12]

proposed different longitudinal predictors of mood states among people with BD along a proximal-distal continuum, starting from the most proximal predictors (prodromes), to recent environmental factors (BAS-relevant life events), and lastly the most distal temperamental features (BAS sensitivity level). However, the model as proposed by Alloy *et al*[6] did not consider the feasible role of coping during the interaction between BAS sensitivity level and BAS-relevant life events.

In essence, coping is a dynamic process that alters according to changing demands and appraisals of situations. In terms of cognitive appraisal, perceived controllability has been seen as one of the key elements[16,17]. With regard to coping patterns, the traditional dimensions include problem-focused and emotion-focused coping[18-20], which can be adaptive in controllable and uncontrollable situations, respectively, according to the good-fit criteria[21]. Regarding coping in BD, previous studies postulated two essential dimensions, one behavioral and one emotional. On one hand, it has been proposed that coping strategies in the behavioral dimension - including "behavioral deactivation" or "behavioral activation" - regulate the mania and depression prodromes, respectively[22-24]. On the other hand, Edge *et al*[25] put forward similar notions but with regard to the emotional dimension. They found that, in response to positive emotions and rewards, people with BD tend to adopt "emotion diminishing" coping strategies instead of "emotion amplifying" coping tactics. This study is therefore focused on exploring the dynamic role of coping in regard to BAS sensitivity level and BAS-relevant life events. Research has indicated the moderating role of stress coping in life events related to BAS[26,27]. When taking BAS dimensions into account, different mood episodes are developed according to the nature of the life events. Therefore, specific coping strategies are necessary for the BAS-relevant life events. In particular, the fit and adaptability of coping should be emphasized. For example, the use of rumination or self-blame can be positively associated with depression, whereas the use of positive appraisal can be negatively associated with these symptoms. Therefore, different forms of coping may help to explain "how" or "why" BAS sensitivity level predicts or causes emotional responses, or meanwhile, it can play a protective role against different BAS sensitivity level as well as BAS-relevant life events.

This study explored the effects of BAS sensitivity levels and coping with BAS-activating life events on mood states among people with BD. Specifically, different clusters were identified in connection with different types of coping strategies. Research has shown that manic BD participants would have a tendency to habitual use of coping strategies more frequently[28] or putting greater effort in spontaneously regulating emotions[29] than healthy controls. Thus, an objective measure of number of coping strategies is implied in this study. Moreover, investigations were performed to test whether coping can play a mediating or buffering role for different BAS sensitivity levels. It was hypothesized that a higher BAS sensitivity level is associated with over-accentuated mood states, in which the use of a higher sense of behavioral-activation/emotion-amplifying (AA) coping should augment the effect on mood states. Alternatively, the use of behavioral-deactivation/emotion-diminishing (DD) coping should further help to regulate heighted mood states.

MATERIALS AND METHODS

Participants

Ethical approval was obtained from the Institutional Review Board of the University of Hong Kong/West Cluster of the Hong Kong Hospital Authority (UW13-176). Ninety participants with BD were recruited from a regional hospital's outpatient clinic. The inclusion criteria were: meeting the criteria cited in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)[30] for diagnosis of bipolar I or II disorder; a required state of full remission for more than 2 mo[31], confirmed by the attending psychiatrists and strictly checked with the corresponding medical records; having been educated to primary level or above; being between the ages of 18 years and 65 years; and being of Chinese ethnicity. Psychiatric diagnoses and remissions were strictly checked with medical records in the hospital. People with a comorbid diagnosis of schizophrenia, schizoaffective disorder, substance abuse, organic brain syndrome, or mental retardation were excluded.

Measures

BAS trait sensitivity: This was measured using the behavioral-inhibition system (BIS)/BAS scales[32]. This self-report scale consists of one BIS subscale and three BAS

subscales: RR, drive (D), and fun-seeking (FS). Specifically, RR measures the sensitivity to pleasant reinforcers in the environment, D measures the motivation to follow one's goals, and FS measures the motivation to find novel rewards spontaneously. Higher scores indicate a higher sensitivity level. Adequate internal consistencies (Cronbach's alphas ranging from 0.66 to 0.81) and good test-retest reliabilities (ranging from 0.59 to 0.69) were established for all of the subscales[32-34]. For this study, translations and cultural adaptations of the scale have been made[35]. The internal consistency reliability (Cronbach's alpha) of the subscales was established ranging from 0.70 to 0.78. Specifically, only the three BAS subscales were used for further analysis.

Coping: This was measured using the Coping Flexibility Questionnaire[16,36], which attempts to capture the simultaneous person-situation transactional processes. At first, 10 BAS activation-relevant life event scenarios were developed with reference to the life events scale[37]. These 10 life events have been discussed, agreed upon, and modified by a pilot focus group of people with BD, *i.e.*, all life events were proven to have comparable BAS-activating effects. All of them were role-played and videotaped by the first author (Chan SHW) and a research assistant. Each scenario was role played for a couple of minutes. The character who needs to make decision in coping was clearly presented. Examples of the 10 events include: "At work, your boss gave you a compliment on your work performance" or "You won an important award due to achievement at work." Then, in the actual field study, two compulsory and two elective scenarios, as chosen by the participants, were presented accordingly. As different individuals may have distinct stressful experiences (and may interpret those experiences differently depending on their illness), exposing each individual to the same nature and number of stressful situations could mitigate this problem[12,38]. Besides, in order to enhance the self-determination level of the participants, they were also advised to make a choice on their own; each was asked to choose two extra life-event scenarios that could be more or less related to his or her living condition, on top of the original two designated life-event scenarios.

The coping indices included the following scores: (1) The perceived controllability score. The participants were asked to view the video clips and vividly imagine encountering in real life the situation portrayed in the life event scenarios. Then, they rated the perceived controllability of the life events on a 6-point scale, with a higher score indicating greater perceived controllability. The scores included the average and the variance of the perceived controllability across the four BAS-activating life events; and (2) The coping strategies score. A list of coping strategies was compiled that included strategies of behavioral-activation and behavioral-deactivation coping[22-24], and emotion-amplifying and emotion-diminishing coping[25]. Participants reported their repertoire of coping responses after their cognitive appraisal. The operationalization of the coping strategies score included the mean and variability (variance) in the number of AA copings (sample items include keeping oneself busy, stimulating coping, self- and emotion-focused coping as well as encouraging rewarding activities) and DD copings (sample items include modifying excessive behavior, engaging in calming activities, avoiding rewarding activities, and dampening responses) across the four different life events.

Mood states: Baseline pre-event affective symptoms (including depressive and manic mood) were measured using the Modified Hamilton Rating Scale for Depression (commonly known as the MHRSD)[39] and the Bech-Rafaelsen Mania Scale (commonly known as the BRMS)[40], respectively. Both scales use a standardized interview format, with higher scores representing higher symptom severity. Post-event mood states were measured using the internal state scale (ISS)[41], which consists of four subscales: Activation (ACT), well-being (WB), perceived conflict, and the depression index. Adequate internal consistencies (Cronbach's alphas ranging from 0.81 to 0.92) have been previously established for all of the subscales. The ISS is a self-report instrument that is sensitive to changes in affective states. Higher scores, specifically in the subscales of ACT and WB, indicate elevated mood states. Translations and cultural adaptations of the scale were also carried out[35], and only the ACT and WB subscales were reported for the present study. Specifically, ACT was used to classify hypomanic (ACT ≥ 200) or euthymic (ACT < 200); whereas, WB was used to classify depressed (WB < 125) or non-depressed (WB ≥ 125). The internal consistency reliability (Cronbach's alpha) of the subscales ranged from 0.61 to 0.85. In the present study, Mansell and Lam[42]'s present state version of the ISS was used. The assessment was completed immediately post-mood induction, enabling the tracking of participants' instant mood states following their viewing of the videotaped vignettes.

Sociodemographic factors

Each participant's sex, age, marital status, educational level, employment status, and residential status were recorded; these were the sociodemographic factors used in this study.

Procedures

First, a list of people with BD attending the outpatient clinic at a regional hospital in Hong Kong was generated. Potential participants who met the inclusion criteria were individually approached by the first author (Chan SHW). After signing a consent form, the participants' baseline pre-event affective symptoms and BAS sensitivity levels were assessed. Subsequently, they were shown video clips depicting two compulsory and two elective BAS-activating life events in a random order. Perceived controllability and corresponding coping strategies for each of these life event scenarios were reported. Finally, the participants' overall post-event mood states were assessed. Each participant was offered a coupon worth Hong Kong $20 (or United States $2.50) for taking part in the study.

Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 24.0 (IBM Corp., Armonk, NY, United States). First, Ward's hierarchical agglomerative clustering method was used to identify the participants' different styles of coping, based on their degrees of perceived controllability and corresponding numbers of coping strategies. The squared Euclidean distance was used as the proximity measure in clustering the data. The stability of the cluster analysis was determined by dendrogram and data visualization method. Cluster differences of various particulars (including BAS sensitivity level, coping, and post-event mood states) were examined through a multivariate analysis of variance or chi-square analysis. A post-hoc Bonferroni's comparison was then employed. *F*-tests were used to assess significant differences between the clusters; partial η^2 values were used to represent effect sizes. To establish evidence of the proposed mediating effect of coping with regard to the relationship between BAS sensitivity level and mood states, the hierarchical regression analyses were carried out according to the procedures advised by Baron and Kenny[43]. Residual plots were checked to determine the random distribution around zero. When determining the moderating effect of coping, hierarchical regression analyses were performed. These strictly followed the procedures recommended by Frazier *et al*[44]. The predictor and moderator variables were standardized to reduce multicollinearity.

RESULTS

General participants' characteristics

A total of 90 participants with bipolar I or bipolar II disorder were successfully recruited for the study (Figure 1). Their mean age was 43.32 years (SD = 11.26), and one-third of them were male (37.7%). Nearly 80% had an educational level above secondary 5. More than a half (55%) were still single, and a majority (80%) were living with others. Regarding employment status, half (50%) were still unemployed. Their relatively low symptom levels resulted in low mean scores of 1.24 and 0.33 in the MHRSD and BRMS, respectively (theoretical ranges of 0-52 and 0-55, respectively). On average, the participants generated 4.56 (SD = 1.93) and 2.24 (SD = 1.31) numbers of AA coping and DD coping, respectively. The associations of all variables in terms of Pearson's correlation are presented in Table 1. Regarding those excluded participants, their mean age was 45 years (SD = 10.34), and nearly 47.3% were male. Within this group, about 63% were unemployed which was comparable with the study group. Thus, there was no significant difference between the consented and non-consented groups.

Identification and comparison of three clusters based on AA and DD coping

To analyze AA and DD coping, a 90 × 12 data matrix was constructed. The unique identification numbers of the 90 participants were entered in the rows, and the raw scores on the perceived controllability of each life event (the first four columns), the number of AA coping (the following four columns), and the number of DD coping (the last four columns) were entered in the columns. There were four sets of three columns, as each participant responded to four life-event scenarios in total. After the data had

Table 1 Correlations of major variables

Variable	BAS_D	BAS_FS	BAS_RR	CTR	AA	DD	ISS_ACT	ISS_WB
BAS_D	1	0.29[b]	0.41[b]	-0.11	-0.05	0.13	0.01	0.02
BAS_FS		1	0.36[b]	0.01	0.18	0.14	0.20	0.07
BAS_RR			1	0.06	0.33[b]	0.30[b]	0.24[a]	0.34[b]
CTR				1	0.42[b]	0.28[b]	0.04	0.30[b]
AA					1	0.57[b]	0.18	0.29[b]
DD						1	0.06	-0.01
ISS_ACT							1	0.70[b]
ISS_WB								1

[a]$P < 0.05$.
[b]$P < 0.01$.
AA: Behavioral-activation/emotion-amplifying coping; ACT: Activation; BAS: Behavioral approach system; CTR: Perceived controllability; D: Drive; DD: Behavioral-deactivation/emotion-diminishing coping; FS: Fun-seeking; ISS: Internal state scale; RR: Reward responsiveness; WB: Well-being.

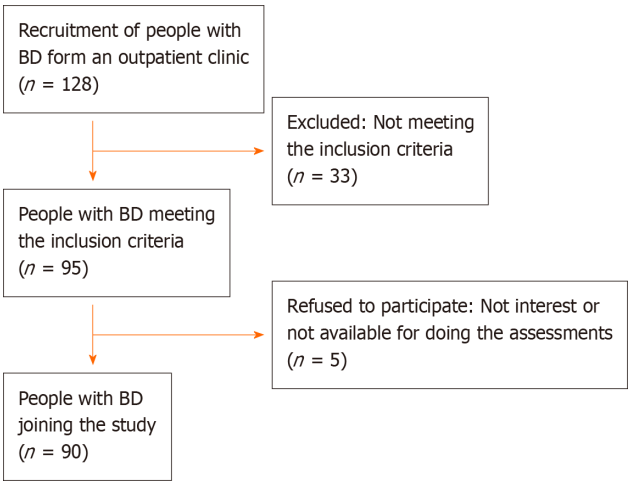

Figure 1 A flow chart of recruitment of participants. BD: Bipolar disorder.

been clustered, a three-cluster solution was found to be the most meaningful and stable (Figure 2 and Table 2). The dendrogram presented in Figure 1 displays all possible options of clustering. In the rightmost part, all participants were grouped together, meaning that there was no clustering at all; whereas, in the leftmost, each participant was paired with another, resulting in too many groups. If there were too many clusters, the subsequent modeling would be too complicated to be interpretable. Conversely, if there were too few clusters (*e.g.*, 2), there would not be distinct coping patterns in each group. This data visualization suggested that the optimal number of clusters should be set at three.

There were no significant differences in the sociodemographic profiles of the three clusters, except in terms of the age of the cluster members. In addition, as long as the baseline affective symptoms were comparable among the three clusters, it was therefore possible to perform further comparison of post-event mood states. Regarding BAS trait sensitivity, there was a statistically significant cluster main effect on the overall BIS/BAS scores (Wilks' $\lambda = 0.798$, $F(6170) = 3.388$, $P = 0.004$, partial $\eta^2 = 0.107$). In further multiple comparisons, an adjusted alpha level of 0.017 (0.05/3) was adopted to correct for the overall Type I errors with regard to three BAS subscales. The members of clusters 1 and 3 were found to be persistent in pursuing their desired goals, as indicated by their significantly higher BAS (D) scores. The members of cluster 1 also had significantly higher BAS (RR) scores than other two clusters; this indicates that their responses to the anticipation of receiving rewards were more positive.

Table 2 Descriptive statistics and comparison of major variables for the three clusters

	Cluster 1, *n* = 26		Cluster 2, *n* = 26		Cluster 3, *n* = 38		
Variables	**Goal achievers with a high mass of coping**		**Goal preservers with a high mass of coping**		**Goal achievers with a low mass of coping**		
	n	**%**	***n***	**%**	***n***	**%**	**Statistics**
Sociodemographic factors							
Sex							χ^2 = 2.13 (P = 0.345)
Female	19	73.1	14	53.8	23	60.5	
Male	7	26.9	12	46.2	15	39.5	
Education level							χ^2 = 7.46 (P = 0.281)
Primary	8	30.8	4	15.4	9	23.7	
Secondary	10	38.4	8	30.8	6	15.8	
Tertiary	8	30.8	14	53.8	23	60.5	
Marital status							χ^2 = 6.72 (P = 0.347)
Single	12	46.2	19	73.1	19	50.0	
Married/cohabited	14	53.8	7	26.9	19	50.0	
Living status							χ^2 = 0.345 (P = 0.987)
Living alone	6	23.0	5	19.3	7	18.4	
Living with others	20	77.0	21	80.7	31	81.6	
Working status							χ^2 = 18.8 (P = 0.171)
Unemployed	17	65.4	11	42.3	17	44.7	
Employed	9	34.6	15	57.7	21	55.3	
	M	SD	M	SD	M	SD	Statistics
Age	48.04	9.64	41.31	12.27	41.47	10.89	F = 3.378 (P = 0.039), 1 > 2, 1 > 3
Baseline affective symptoms							
MHRSD	1.19	1.13	1.38	1.47	1.18	1.25	F = 0.217 (P = 0.805)
BRMS	0.50	1.03	0.38	0.80	0.18	0.56	F = 1.31 (P = 0.275)
BAS sensitivity level							
BAS_D	12.85	1.62	11.62	1.68	12.79	1.76	F = 4.622 (P = 0.012) 1 > 2, 3 > 2
BAS_FS	12.19	2.43	11.42	2.47	11.13	2.70	F = 1.351 (P = 0.264)
BAS_RR	17.85	2.05	15.65	3.11	16.05	2.27	F = 5.924 (P = 0.004) 1 > 2, 1 > 3
Coping							
CTR	2.80	0.74	2.5	0.64	1.68	0.66	F = 23.505 (P < 0.001) 1 > 3, 2 > 3
VCTR	2.70	2.41	1.88	1.10	2.90	2.30	F = 1.998 (P = 0.142)
AA	5.90	1.25	4.68	0.94	2.72	1.27	F = 58.999 (P < 0.001) 1 > 2, 1 > 3, 2 > 3
VAA	1.46	1.83	1.95	1.33	2.08	2.10	F = 0.919 (P = 0.403)
DD	4.28	0.88	2.19	0.61	1.72	0.99	F = 71.542 (P < 0.001) 1 > 2, 1 > 3, 2 > 3
VDD	1.23	0.92	0.94	0.79	0.74	0.62	F = 3.242 (P = 0.044)
Post-event mood states							
ISS_ACT	226.15	99.08	162.31	111.94	182.89	116.90	F = 2.281 (P = 0.108)

ISS_WB	194.62	65.38	139.62	79.22	156.84	77.50	F = 3.728 (P = 0.028)

AA: Behavioral-activation/emotion-amplifying coping; ACT: Activation; BAS: Behavioral approach system; BRMS: Bech-rafaelsen mania scale; CTR: Perceived controllability; D: Drive; DD: Behavioral-deactivation/emotion-diminishing coping; FS: Fun-seeking; ISS: Internal state scale; MHRSD: Modified Hamilton Rating Scale for Depression; RR: Reward responsiveness; VAA: Variance of behavioral-activation/emotion-amplifying coping; VCTR: Variance of perceived controllability; VDD: Variance of behavioral-deactivation/emotion-diminishing coping; WB: Well-being.

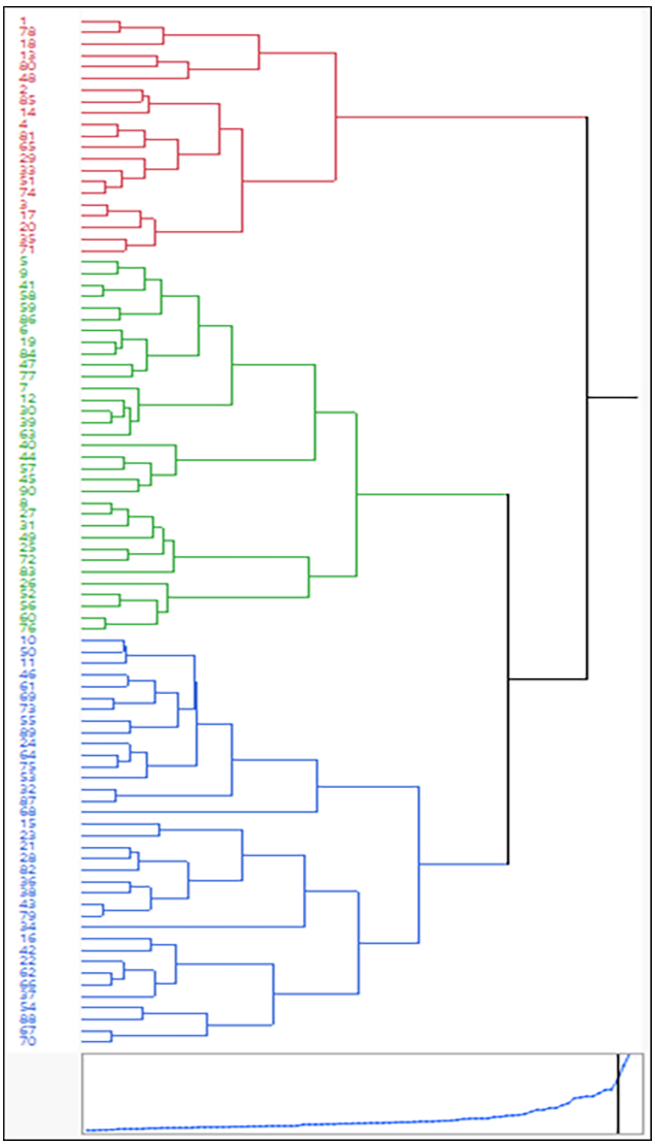

Figure 2 Dendrogram of hierarchical cluster analysis.

Regarding coping scores, there was a statistically significant cluster main effect on the overall scores (Wilks' λ = 0.173, $F(12164)$ = 19.172, P < 0.001, partial η^2 = 0.584). In further multiple comparisons, an adjusted alpha level of 0.008 (0.05/6) was adopted in response to the six different scores that comprised the coping indices. Specifically, the members of cluster 1 (labeled "Goal achievers with a high mass of coping") were characterized by a high level of BAS sensitivity and as using the greatest number of coping strategies with higher degree of perceived controllability. The members of cluster 2 (labeled "Goal preservers with a high mass of coping strategies") were characterized by a low BAS sensitivity level and as using a moderately large number of coping strategies with higher degree of perceived controllability. The members of cluster 3 (labeled "Goal achievers with a low mass of coping") were characterized by a high BAS sensitivity level but also as using the smallest number of coping strategies with lower degree of perceived controllability. For post-event mood states, there was no statistically significant cluster main effect on the overall ISS scores (Wilks' λ = 0.920,

F(4172) = 1.838, *P* = 0.124, partial η^2 = 0.041). However, the members of the "Goal achievers with a high mass of coping" cluster 1 had the highest ISS scores. The effect sizes were small to moderate, as indicated by the partial η^2 values (which ranged from 0.050 to 0.079).

Mediating effect of coping

As the sample size of each cluster was relatively small, the entire sample was used for calculation of the mediation or moderation effects. Following the analyses, only AA coping was found to meet the three conditions stipulated by Baron and Kenny[43]. The results are presented in Table 3. First, ISS (WB) was positively related to BAS (RR) (β = 0.335, *P* < 0.001). When BAS (RR) and AA coping were taken together in the regression analysis, the relationship between BAS (RR) and ISS (WB) was found to be weaker but still significant (β = 0.268, *P* < 0.001). Baron and Kenny[43] suggested that it was a partial mediation model. This partial mediation model was verified by the Sobel *z*-test [45] (*Z* = 2.156, *P* < 0.05).

Moderating effect of coping

The results are shown in Table 4. When the effects of sex and age were controlled for in block 1, some of the components of coping — including AA coping, perceived controllability, and variability of perceived controllability — were found to moderate the association between BAS sensitivity level and mood states. As recommended by Aiken and West[46], simple slope tests were performed to compare the effect of BAS sensitivity level on the mood states of individuals with high (1 SD above the mean) and low (1 SD below the mean) levels of coping. The results showed that the associations between BAS sensitivity level and mood states were negative among individuals with low levels of coping including AA coping, perceived controllability, and variability of perceived controllability (β = -0.735 to -0.019), whereas the associations were positive among individuals with high levels of coping (β = 0.202 to 0.497).

DISCUSSION

This study demonstrates how the judicious use of coping can help in emotion regulation for people with BD when encountering BAS-activating life events. Echoing previous research findings, it was found that higher BAS sensitivity levels[6,11] resulted in higher mood states. By comparing individuals between clusters 1 and 2, it was demonstrated that a higher degree of perceived controllability and using higher numbers of coping strategies can further over-activate an individual's mood state. Alternatively, when comparing clusters 1 and 3, with similar levels of BAS sensitivity, a lower degree of perceived controllability and using lower numbers of coping strategies were found to regulate heightened mood states.

With regard to the cognitive appraisal in terms of the high degree of perceived controllability, the judgment on an appraisal in the coping process may be colored by individual affective state[47], which should be related to the BAS sensitivity level, as shown in this study. Perceived controllability may connote taking an active role or exerting effort to alter the environment. Therefore, reducing the perceived controllability of life events seems to imply the notion of "non-striving," which is one of the core ideas in mindfulness[48-50]; as such, it is no wonder that mindfulness-based intervention is a plausible way to enhance mood regulation in BD[51].

Particularly, the mediation model showed that if an individual has a higher level of BAS sensitivity, this results in over-activation of mood states by stimulating the use of AA coping strategies. These results supplement previous findings[6,12,34] by verifying the role of the BAS dysregulation system in people with BD. The emotion amplifying intention is also in line with the findings of Stange *et al*[52], who suggested that individuals with high levels of BAS sensitivity exhibit greater emotion-focused rumination that may result in manic/hypomanic-like symptoms.

In addition, the moderation model suggests that subduing the use of AA coping, perceived controllability, and variability of perceived controllability was advantageous for people with high levels of BAS sensitivity, as it prevents the detrimental accentuation of mood states. That is, to attenuate their mood states, individuals with high levels of BAS sensitivity should utilize relatively less strategies — such as keeping oneself busy or encouraging rewarding activities — after exposure to BAS-activating life events. This kind of adaptation in coping should also extend the application of the dual process theory of coping flexibility[53] in mood regulation for people with BD. However, the alternative approach of increasing use of DD coping

Table 3 Mediating effect of behavioral-activation/emotion-amplifying coping between behavioral approach system sensitivity level and mood states (with dependent variable as internal state scale_well-being)

Variables	*B*	*SE B*	*β*
Step 1			
Outcome: ISS_WB			
Predictor: BAS_RR	9.841	2.953	0.335[b]
Step 2			
Outcome: AA			
Predictor: BAS_RR	0.244	0.074	0.332[b]
Step 3			
Outcome: ISS_WB			
Mediator: AA	8.054	4.186	0.202[a]
Predictor: BAS_RR	7.873	3.084	0.268[b]

[a]$P < 0.05$.
[b]$P < 0.01$.
AA: Behavioral-activation/emotion-amplifying coping; BAS: Behavioral approach system; ISS: Internal state scale; RR: Reward responsiveness; WB: Well-being.

could not be confirmed from the present results. Perhaps people with BD may tend to avoid use of some strategies, such as dampening response, by classifying them as maladaptive strategies[14]. Some individuals may even express ambivalence towards self-help strategies for the managing of high mood episodes[54]. It is necessary for there to be further investigation into the effectiveness of interventions for BD that emphasize the utilization of DD coping.

Nevertheless, cautions have to be taken in interpreting the findings. A general BAS sensitivity level and overall mood states were used for discussion here, despite there being different subscales presented in the BAS scale or ISS. There could exist a differential relationship between different subscales. ISS (WB) was found to be the common significant outcome in both mediation and moderation models; yet, the predictors involved were distinct. Only BAS (RR) was found in the former; whereas, BAS (D) and BAS (FS) were indicated in the latter. Perhaps the AA coping can be used to explain the contributing reason of sensitivity towards pleasant reinforcers leading to increased mood states. On the other hand, the reduced use of AA coping or perceived controllability can help to reduce the effects on elated mood due to motivation to goals or rewards. Future research is worthwhile for investigating the differences of various BAS or mood states' representation, especially for the mediating or moderating roles of coping. Moreover, videos were used as stimuli in this study. Despite having been found to be a reliable means by which to induce positive mood change[55], future research can be considered to compare different natural *vs* artificial means for eliciting varied mood states.

People who experience positive affect should have better psychological health, but over-elevated mood may not be adaptive for people with BD[56]. The judicious use of coping appears to be vital in managing positive affect or over-elevated mood among people with BD. Originally, the framework of coping was applied only to "negative" or stressful life events[57,58]; applying this framework to "positive" life events, as in the present study, has the potential to generate another conceptual viewpoint. Undoubtedly, people "cope" with positive events in order to cultivate higher positive affect and greater life satisfaction[59,60]. Folkman and Moskowitz[61] have also highlighted the beneficial effect or adaptational significance of positive affect in the midst of stress. However, positive affect as induced by positive events may do harm to people with impaired emotion regulation[37,62]. Coping with both positive effect and negative affect play equivalent roles in cases of people with BD. Broadening models of coping in the present study will help people with BD to gain greater insight into enhancing their competencies in emotion regulation.

This study also has important clinical significance and practical implications for the improvement of stress management programs for people with BD. Conventionally, and in most previous programs[63,64], participants have learned only general coping

Table 4 Moderating effect of coping between behavioral approach system sensitivity level and mood states (with dependent variable as internal state scale_well-being)

Variables	*B*	*SE B*	*β*	R^2	R^2 change	*F* change
Moderator: AA coping						
Block 2				0.137	0.069	3.405[a]
BAS_D	-0.236	7.417	-0.003			
AA	15.417	7.861	0.200			
Block 3				0.234	0.097	10.609[b]
BAS_D × AA	24.777	7.607	0.323[b]			
Moderator: CTR						
Block 2				0.153	0.085	4.256[a]
BAS_D	1.107	7.552	0.014			
CTR	18.150	7.757	0.236[a]			
Block 3				0.214	0.061	6.570[a]
BAS_D × CTR	16.691	6.512	0.258[a]			
Moderator: VCTR						
Block 2				0.086	0.019	0.864
BAS_FS	7.192	8.021	0.093			
VCTR	8.918	7.934	0.116			
Block 3				0.142	0.056	5.437[a]
BAS_FS × VCTR	-15.334	6.576	-0.239[a]			

[a]$P < 0.05$.
[b]$P < 0.01$.
AA: Behavioral-activation/emotion-amplifying coping; BAS: Behavioral approach system; CTR: Perceived controllability; D: Drive; FS: Fun-seeking; ISS: Internal state scale; VCTR: Variance of perceived controllability; WB: Well-being.

skills but not situation-specific ones. Enhancing individuals' understanding of how to differentiate effectively between various stressful situations may enhance their use of coping. Moreover, the emphasis of such a program has typically focused on negative life events. In fact, positive life events also play a significant role for people with BD with regard to life stress in general. This study promotes maintaining the balance of helping people with BD to cope with the later. Taking into account an individual difference in BAS sensitivity level, people with BD can deploy appropriate coping strategies to meet the different challenges that arise from various stressors. For example, "low degree" coping may help to stabilize the mood state of an individual with BD in situations where they are exposed to BAS-activating life events. Echoing the findings of Edge *et al*[25] that people with BD intentionally find appropriate ways to avoid mania so as to allow them to stay well[65], modification of such individuals' coping repertoire should lead to beneficial changes in their mood states. Thus, teaching the judicious use of various coping strategies in terms of AA or DD coping as well as facilitating proper attitude in reducing perceived controllability can further enhance the treatment effects of the stress management program for BD.

This study had some notable limitations. First, "polarity-specific" life events[66,67] either activate or deactivate the BAS in a dynamic process. However, this study focused only on a single pathway with respect to BAS-activating life events. Second, this study examined only people with BD, without a control group for comparison. People without BD should have lower BAS trait sensitivity levels, which may require a less emotion-driven consideration, so it may bring in a distinctive representation for individuals without BD. In addition, persistent cognitive deficits are common in people with BD even when they are euthymic[68], in which ventrolateral prefrontal cortex dysfunction was also demonstrated as a trait-related abnormality in people with euthymic BD[69]. Thus, future studies that compare euthymic BD with a healthy control group regarding the decision making in choosing coping strategies would be

of interest. Third, because only cross-sectional correlation statistics were utilized in this study, no definitive statement on causality can be made. Using a lower number of coping strategies can regulate heightened mood states, but it is also possible that the effect goes the other way around. Further longitudinal research is needed to achieve an understanding of the directionality. Moreover, the small sample size of this study may have affected the findings. In particular, the size of each cluster was quite small, and this may have affected the validity of the findings.

Despite these limitations, this study does provide novel insights into the landscape in which BAS sensitivity level and coping affect the mood states of people with BD. Investigations of this kind significantly improve our ability to identify potential vulnerabilities or protective factors that influence the course of recovery for people with BD. BAS-activating life events have been reckoned to have a prospective association with people's propensity to experience increasingly severe manic symptoms[33]. Thus, people with BD may be likely to over-activate their positive emotions or develop manic/hypomanic mood symptoms after exposure to the corresponding events. In essence, BD is characterized by amplified emotionality[13] together with difficulty in regulating emotion[70,71]. The ability to regulate their emotions, using appropriate coping strategies for various different life events, is therefore of paramount importance for people with BD.

CONCLUSION

Using a small number of coping strategies appears to be an adaptive emotion regulation strategy[72] for maintaining an euthymic state for people with BD. More specifically, as shown in this study, reducing the use of AA coping should be effective in countering high BAS sensitivity level, especially when coping with BAS-activating life events.

ARTICLE HIGHLIGHTS

Research background

Individuals with bipolar disorder (BD) frequently struggle with the recurrence of affective symptoms. However, the interplay between coping mechanism and positive mood state remains under-researched.

Research motivation

To add to the current knowledge about the role of coping in emotion regulation in people with BD.

Research objectives

The main objective was to explore the associations between the behavioral approach system (BAS) sensitivity level, coping flexibility, and mood states among people with BD after they encounter BAS-activating life events.

Research methods

Using a cross-sectional study design, 90 participants with BD were presented with four BAS-activating life event scenarios and assessed with regard to their BAS trait sensitivity, coping flexibility, and mood states. A hierarchical clustering method was used to identify different groups with different styles of coping. Multiple hierarchical regression analyses were conducted in order to examine the mediating and moderating roles of different components of coping on mood states.

Research results

A three-cluster solution was found to best fit the present data set. The findings showed that a low mass of coping combined with low BAS sensitivity level protects people with BD from detrimentally accentuating mood states when they encounter BAS-activating life events. Moreover, coping flexibility is demonstrated to mediate and moderate the relationships between BAS sensitivity level and mood states. Specifically, subduing the perceived controllability and reducing the use of behavioral-activation/emotion-amplifying coping strategies could help buffer the effect of positive affect.

Research conclusions

The judicious use of coping in emotion regulation for people with BD when encountering BAS-activating life events was indicated.

Research perspectives

The findings of this study have practical implications for the improvement of stress management programs. Theoretically, this study helps integrate the concept of coping flexibility into the BAS dysregulation theory as it applies to mental illness.

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