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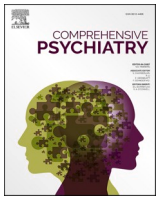

Identifying internalizing transdiagnostic profiles through motivational and cognitive control systems: Relations with symptoms, functionality, and quality of life

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ABSTRACT

Background: The diversity of patients' symptomatology among people seeking treatment on community-based mental health services poses significant challenges to traditional models of care. Recent approaches favor identifying transdiagnostic factors that allow a better understanding of patient heterogeneity and designing more effective and quality interventions. This study examines the heterogeneity of patients with internalizing symptoms based on profiles identified with cognitive and motivational control variables. Differences between these profiles on dimensional measures of psychopathology and quality of life are examined.

Methods: 263 patients were selected by non-probabilistic sampling procedures on mental health services in the province of Huelva (Spain). A latent class analysis on the standardized scale scores of The Behavioral Inhibition/Behavioral Activation System Scales and the Effortful Control Scale of the Adult Temperament Questionnaire Short-Form was conducted. Profiles were compared on the scores of the Inventory of Depression and Anxiety Symptoms-II, the WHO Disability Assessment Schedule II, and the Health Assessment Questionnaire SF-36.

Results: The four latent profile solution is the one that showed the best fit indicators and substantive interpretability, with a kappa of 0.94 in the cross-validation procedure with 75% of the sample. No sex differences were found between the profiles (χ^2_3 5.17, $p = .160$). Profiles #1 and #3, both characterized by an imbalance between low activation and high inhibition, had lower well-being, lower functionality, and quality of life. When comparing profile #2 (featuring the highest inhibitory control) lower scores on most internalizing scales are observed, specially claustrophobia, social anxiety, panic mania. Profile #4 (low control, high activation, and high inhibition) showed greater scores on both mania and euphoria and lower scores on emotional role.

Conclusions: We identified four distinctive profiles that had overly increased behavioral inhibition (as expected in internalizing disorders) and differed in the degree of imbalance between inhibition and activation systems, and between motivational systems and top-down cognitive control. The profile characterized by high activation and reduced cognitive (inhibitory) control was the one showing greater mood-related symptoms and lower levels of quality of life. These profiles could be generated by treatment providers to guide clinical management in an evidence-based manner.

1. Introduction

Internalizing disorders are characterized by emotional distress and/or avoidance behaviors, including mood, anxiety, or obsessive-compulsive disorders among others. These are leading drivers of the global disease burden due to mental illness [1]. They are highly represented among people seeking treatment in community-based mental health services [2] and frequently co-occur with other mental disorders [3]. The wide diversity of clinical presentations, both within and beyond the internalizing spectrum [4], and varying levels of functioning, hence

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pose significant challenges to mainstream models of care [5,6]. In this vein, transdiagnostic approaches strive to identify shared mechanisms contributing to the onset and maintenance of a range of diagnoses, beyond the traditional diagnostic labels [5].

Recent meta-analyses suggest that emerging transdiagnostic interventions for internalizing disorders may be more effective than traditional interventions directed at specific disorders [7–9]. In this context, identifying transdiagnostic profiles may efficiently parse heterogeneity and enable precision-based interventions. Temperament measures of motivational reactivity and cognitive control systems are promising tools to dissect heterogeneity and identify transdiagnostic profiles as they tap into the mechanisms that underpin several mental disorders and diverse symptoms [10]. While motivational systems shape individuals' tendency to approach rewards or avoid punishing stimuli (i.e., dispositional reactivity to potential reward or threat), effortful control modulates one's reactivity to these stimuli [11]. In this vein, the application of dimensional measures of motivational and control systems to yield transdiagnostic profiles could not only lead to better understanding of heterogeneity of patients but also to precision-based interventions that can improve the overall efficacy and quality of care for people with internalizing disorders.

This approach aligns with contemporary frameworks of research in mental health, such as the Research Domain Criteria (RDoC) model [12], which conceptualize mental health along various constructs and levels of analysis, linking motivational and cognitive control processes as transdiagnostic domains with well-defined neurobiological substrates and behavioral dispositions. Empirical evidence indicates RDoC domains of Negative Valence Systems, Positive Valence Systems and Cognitive Systems constructs are consistently linked to internalizing problems [13,14]. In this vein, current theories posit the existence of at least three separate interactive systems: behavioral activation or positive emotionality, behavioral inhibition or negative emotionality, and effortful or cognitive control [15]. The behavioral activation system (BAS) promotes approach-related reactivity and reward-seeking behaviors and is linked to positive emotional traits such as curiosity and excitement. On the other hand, the behavioral inhibition system (BIS) fuels avoidance related reactivity aimed at preventing danger and potential harm and is related to negative emotions such as fear and distress [16]. Finally, the effortful control system (ECS) orchestrates goal-directed behavior, and thus regulates both the activation and inhibition of behavior in alignment with goals and values, acting as protective factor by reducing the risk associated with a high BIS and BAS [17].

The balanced function of the three systems described above enables optimal allocation of behavior and emotion regulation, and thus facilitates overall adaptive functioning [15]. Conversely, congruent with the premises of triadic models, imbalanced function of these bottom-up (BIS, BAS) and top-down (ECS) processes can lead to distinct psychopathological profiles [18]. Existing studies in clinical populations have mainly focused on the imbalance between the BIS and BAS systems in specific disorder groups. Generally, anxiety disorders have been linked to increased BIS sensitivity and depression associated with reduced BAS [19]. Furthermore, the balance between BIS and BAS can segregate different subtypes of mood disorder, as people with unipolar depression show elevated BIS and reduced BAS whereas those with bipolar disorder show elevated BIS but also relatively high BAS [20]. Furthermore, higher BAS, even in the context of elevated BIS, is associated with better clinical functioning and less chronicity in people with other disorders such as anorexia nervosa or schizophrenia [21,22]. Very few studies have triangulated measures of BIS, BAS and ECS in clinical populations, but evidence (stemming mostly from studies in healthy participants) suggests that people with high BIS, low BAS and low ECS are particularly likely to show symptoms of depression [15]. Similarly, high BIS together with low ECS has been associated with high levels of anxiety, whereas high BAS and high ECS correlate with low levels of anxiety [15]. Altogether, available studies highlight the link between imbalanced function of BIS, BAS and ECS and internalizing psychopathology, although mostly conducted among healthy samples displaying symptoms of these disorders, and thus stress the need of studies that triangulate measures of these three systems within clinical populations.

In addition to the sparse number of studies including BIS, BAS and ECS measures in internalizing disorders, existing studies have used traditional case-control or diagnostic group comparisons (e.g., unipolar versus bipolar groups). The symptom overlap across diagnostic categories [23], the heterogeneity of symptoms among patients diagnosed with the same disorder [24], and the differential contribution of specific symptoms to functionality and quality of life [25], underscore the relevance of analyzing how motivational reactivity (BIS, BAS) and effortful control (ECS) based profiles may contribute to parse heterogeneity across disorders. According to the Santens et al.'s review of studies in subclinical populations and discrete disorders [15], three different profiles could be described. First, a “resilient” profile with low BIS, moderate BAS and high ECS; this group usually show mild psychopathological symptoms. A second “overcontrolled/inhibited” profile of patients is associated with greater symptoms of internalizing disorders and feature high BIS, low BAS, and moderate ECS scores. A third cluster shows moderate BIS, high BAS and low ECS scores, reflecting “undercontrolled/dysregulated” characteristics, and is associated with symptoms of cluster B and C personality disorders. Thus, examining how motivational reactivity and control profiles differ in terms of symptom patterns and levels of functioning (e.g., “resilient” versus “overcontrolled” or “undercontrolled” profiles), can improve our understanding of psychopathology by differential positions on these shared underlying dimensions and ultimately better tailor intervention approaches.

Considering that studies to date have been conducted mostly in samples of healthy participants and specific disorder groups, here we adopt a novel transdiagnostic perspective, with the aim of identifying multidimensional profiles based on BIS, BAS and ECS measures in a heterogeneous group of patients enrolled in community-based mental health services. Given the high prevalence, mixed presentation with multiple components of psychopathology and comorbidity of internalizing disorders in such settings, identifying transdiagnostic profiles is particularly important to improve understanding of the specific motivational and control drivers impacting mental health and wellbeing among different subgroups. Previous research [21,26–29] was also limited to BAS and ECS main scales (BIS has no subscales), but we will do a more fine-grained analysis by analyzing on subscale level. Thus, the aim of this study is to leverage motivational and cognitive control systems profiling to parse heterogeneity among participants with mental ill-health, mostly due to internalizing disorders. We hypothesized to derive at least three different transdiagnostic profiles characterized by relative imbalance of BIS, BAS and ECS [15,27,29]. Profiles will be further validated by examining their association with dimensional measures of psychopathology and quality of life. We hypothesized that the profiles will show distinct psychopathological profiles and levels of quality of life / function.

2. Methods

2.1. Participants and procedure

A criterion of representability of patients using mental health services was used to determine the adequate sample size, ensuring that the sample mirrors the prevalence of disorders and characteristics within the patient population. According to the latest available internal report of 2017, a total of 16,620 patients attended (59.05% women) Community Mental Health Units (hereinafter CMH) in the province of Huelva, the geographical area where the study data was collected. Diagnoses of mood and anxiety disorders ranged between 76.42% and 84.74% (depending on the mental health unit). Based on this sampling frame, with a margin of error of ±5%, a confidence interval of 95% and a distribution of 80%, the sample size necessary to complete the study was

approximately 230 patients.

After computing the required sample size, participants were recruited among patients of mental health services in the province of Huelva (Spain), during the period May 2022 to May 2023. Since there was no previous census of patients attending mental health care services, a non-probabilistic systematic sampling procedure was employed for including consecutively admitted patients initiating treatment during the study period. Inclusion criteria were: 1) age between 18 and 80 years, and 2) initiating treatment in a mental health service during the data collection period. Patients with a medical or psychological diagnosis that precluded the administration of the tests (e.g., acute psychotic disorders or severe or severe intellectual disability) were excluded.

During the study period, all patients who met the admission criteria were invited to participate during patients' sessions with their clinicians in the mental health services. The clinicians explained the study and indicated the purpose of the study and informed patients that it was unrelated to and would not influence their treatment at the mental health services. If patients wanted to participate and signed the informed consent, a trained psychologist administered the tests. All patients were interviewed in the center where the patients received their treatment. Participants were rewarded with an economic compensation of 10 euros for their time. Test administration lasted approximately 1 h. The study protocol and procedure have been approved by the Ethics Committee of Research Centers in the province of Huelva (Junta de Andalucía, Spain) (file number 0275-N-21).

The final sample consisted of 263 people, 74.5% women ($n = 196$), with a mean age of 39.29 ($SD = 15.24$). Regarding educational level, 2.7% of participants had not completed primary education, 8.42% had completed primary education, 68.1% had completed secondary education and 20.9% had completed university studies. 36.5% were employed at the time of completing the study. The most frequent diagnostic categories according to DSM-5 were Major Depression (56.6%) and General Anxiety (49.0%). Although the primary interest of present study was aimed on internalizing disorders, participants showed comorbidities, including non-internalizing disorders. Table 1 shows the diagnoses present in the clinical sample determined by the Mini-International Neuropsychiatric Interview (MINI) [30].

2.2. Instruments

Behavioral Inhibition/Behavioral Activation System Scales (BIS/BAS), Spanish version [31]. The instrument consists of 20 items (+4 filler items) which are rated on a 4-point Likert scale (ranging from 1 = I totally agree to 4 = I totally disagree). It measures the reactivity of two motivational systems (reward and punishment), with three BAS-related scales: BAS drive -DR- (items pertaining to the persistent pursuit of desired goals); BAS Fun seeking -FS- (reflecting both desire for new rewards and a willingness to approach a potentially rewarding event); BAS Reward Responsiveness -RR- (focusing on positive responses to the occurrence or anticipation of reward); and one BIS-related scale referring reactions to the anticipation of punishment. Cronbach's alpha coefficient for the present sample reached the following values on each scale DR $\alpha = 0.74$, FS $\alpha = 0.57$, RR $\alpha = 0.65$, BIS $\alpha = 0.74$.

Table 1
Distribution of demographic and diagnostic information (N = 263).

	n (%)	M(SD)
Women	196 (74.5)	
Age		39.29 (15.24)
Not completed Primary Education	7 (2.7)	
Primary education level	22 (8.4)	
Secondary education level	179 (68.1)	
Higher Education level	55 (20.9)	
Employed	96 (36.5)	
Bipolar and Related Disorders	20 (7.6)	
Major Depression Disorder	143 (54.3)	
General Anxiety Disorder	122 (46.3)	
Panic Disorder	66 (25.1)	
Agoraphobia	35 (13.3)	
Social phobia	30 (11.4)	
Obsessive-Compulsive and Related Disorders	77 (29.3)	
Trauma- and Stressor-Related Disorders	49 (18.6)	
Substance use disorders	14 (5.3)	
Feeding and Eating Disorders	13 (4.9)	
Antisocial Personality Disorders	5 (1.9)	

Effortful Control (EC) Scale of the Adult Temperament Questionnaire Short-Form. Spanish version [32], which includes 19 items grouped in three subscales: Inhibitory control -InC- (ability to suppress inappropriate approach behavior); Attentional control -AtC- (capacity to focus and shift attention when desired); and Activation control -AcC- (ability to perform an action when there is a strong tendency to avoid it). Cronbach's alpha coefficient range for the present sample obtained the following values: InC $\alpha = 0.57$, AtC $\alpha = 0.70$, AcC $\alpha = 0.62$.

Inventory of Depression and Anxiety Symptoms-II (IDAS-II), Spanish version [33]. The IDAS-II is composed of 99 items with a 5-point scale (from 1 = "not at all" to 5 = "extremely") that assess the severity of symptoms of major depression, general anxiety and bipolar disorder during the last two weeks. The items are grouped into 18 specific scales corresponding to internalizing symptoms: Appetite gain (increased interest in food and eating when not hungry); Appetite loss (reduced interest in food and eating less than usual); Checking (worrying about whether a intended activity was actually done); Claustrophobia (fear of small, tight spaces); Cleaning (worry about dirt, excessively concerned with cleanliness); Dysphoria (feeling sad and discouraged); Euphoria (feeling extremely elated, excessive energized); Ill temper (feeling irritable or bad-tempered); Insomnia (reduced sleep quantity and/or quality); Lassitude (feelings of fatigue and reduced energy); Well-being (feeling optimistic and enthusiastic); Mania (mental and psychical hyperactivity); Ordering (repeatedly counting object or needing to perform certain activities in a certain way); Panic (feeling faint, shortness of breath or trembling); Social anxiety (feeling uncomfortable interacting with people); Suicidality (thoughts about death and killing oneself); Traumatic avoidance (attempts to avoid places, people of activities reminding a traumatic event); Traumatic intrusions (flashbacks, disturbing thoughts or memories of a traumatic event).

Higher scores indicate greater symptom severity. Cronbach's alpha for the symptom scales ranged in present sample from 0.68 (Lassitude) to 0.91 (Appetite Loss).

32 items Spanish version of the WHO Disability Assessment Schedule II (WHODAS 2.0) [34] was used to measure functional impairment. Each item is scored on a 5-point Likert scale (from 0 = "none" to 4 = "extreme or cannot do") which grades the difficulty experienced by the participant in performing a given activity. This instrument provides an overall score and six specific domains: Cognition (understanding and communicating), Mobility (moving and getting around), Self-Care (hygiene, dressing, eating and staying alone), Getting-Alone (interacting with other people), Life Activities (domestic responsibilities, leisure, work and school) and Participation in Social Life (joining in community activities). All scores range from 0 to 100 where higher scores mean greater impairment. Cronbach's alpha coefficient range 0.67 (Self-Care) to 0.82 (Mobility) for the present sample.

Health Assessment Questionnaire SF-36, Spanish version [35] was used to assess health-related quality of life (HRQoL). Its 36 items measure 8 health related domains: Physical Functioning (extent to which health limits physical activities such as walking, lifting weight); Role Physical (extent to which physical health interferes with work and other daily activities), Body Pain (perceived pain and its effect on normal work), General Health (self-perception of health, including current health and future health expectation); Vitality (feeling of energy), Social Functioning (degree to which physical or emotional health problems interfere with regular social life), Role Emotional (extent to which emotional problems interfere with work or other daily activities) and Mental Health (general mental health, including depression, anxiety, behavioral management and emotional control). Cronbach's alpha coefficient range

0.72 (Role Emotional) to 0.91 (Physical Functioning) for the present sample.

2.3. Analyses

To identify subtypes of patients based on BIS/BAS/EC, a latent class analysis on the standardized BIS/BAS and EC scale scores was conducted.

The optimal number of latent profiles was determined by evaluating the goodness of fit of each model (from 2 to 5 classes) according to Bayesian Information Criterion (BIC), sample-adjusted BIC (SABIC), and Akaike Information Criteria (AIC). Bootstrap Likelihood Ratio test (BLRT), and entropy were also considered. Lower BIC, SABIC and AIC values indicate a better fit of the model. LMR and BLRT compare the estimated model with a median with k-1 classes, where k is the number of classes. Significant values of LMR and BLRT indicate that the estimated model is better than the model with one class less. Entropy values range from 0 to 1, where values closer to 0.80 indicate a more accurate classification. To determine the most optimal solution, as suggested by literature [36] the selection of a final model considered several and complementary criteria including fit indices, interpretability of classes, and a minimum percentage of 5% of subjects included in each class.

To determine the stability or replicability of the profiles, a cross-validation procedure was performed by randomly selecting 75% of the sample [37]. The LCA was again applied to the random subsample and the agreement between the solution and the solution on the overall sample was tested using Cohen's Kappa [38]. Kappa values above 0.80 are considered as indicator of strong agreement. Cross-validation is recommended as a procedure to prevent overfitting and improve model selection [37,39].

To analyze the differences between found profiles on internalizing symptoms, functionality and quality of life, a Multivariate Analysis of Variance was applied. Due to the unbalanced sample size, homogeneity variance test was performed and Welch robust test was applied on those comparisons where heteroscedasticity was detected [40]. Comparisons were also made with scores from the normal population for BIS/BAS [41], EC [42], IDAS-II [43]. SF-36 and WHODAS 2.0 use scoring algorithms that transform raw scores to a normative scale of mean 50, standard deviation 10, used to interpret scores on a general population basis [34,35]. Reference scores of external scales were compared to profiles using *t*-tests. A Bonferroni *p*-value correction for multiple comparison was applied. The comparison of diagnoses across profile, through Chi-square test is also included as Supplementary Table S1.

Latent class analyses were performed in MPlus version 8.7 [44]. Rest of analysis were conducted using SPSS version 28.0 [45].

3. Results

3.1. Latent profiles

The goodness of fit of the models explored indicate that the four latent profile solution is the one that showed the best fit indicators and substantive interpretability. It also had a high kappa in the cross-validation procedure with 75% of sample (Table 2).

Profile #1 comprised 117 participants, with mean probability of fitting of 0.89 (range: 0.44–0.99). Profile #2 included 52 patients with mean probability of fitting of 0.87 (range: 0.35–1). Profile #3 grouped 26 participants with mean probability of fitting of 0.92 (range: 0.51–1) and profile #4 included 68 participants with mean probability of fitting of 0.83 (range: 0.43–0.1). No gender differences were found between the profiles (χ^2_3 5.17, $p = .160$).

Standardized scores of BAS, BIS and ECS scales are shown in Fig. 1. Compared to normative scores in the general population [42,43], the four groups had overly elevated BIS and moderately reduced BAS; there were mixed patterns (both elevations and reductions across the groups) regarding ECS (see Table 3).

We compared each of the profiles to the normative scores as well as to the other profiles when further characterizations were needed (Table 3). All four profiles score notably high on BIS but show distinctive characteristics. Profile #1 showed high BIS, lower overall BAS, and lower Attentional and Inhibitory Control. Profile #2 displayed high BIS, but normal scores on BAS fun-seeking and high scores on all ECS scales. Profile #3 showed higher scores on BIS, lowest scores across all BAS scales, and distinctly, higher Inhibitory Control but a lower level of Attentional Control. Finally, Profile #4 featured high BIS and higher fun seeking, but lower Attentional Control – relative to norms (similar to Profiles #1 and #3) – and lower Inhibitory Control – relative to the other three profiles –.

3.2. Differentiation of profiles in terms of emotional symptoms

Regarding psychopathological symptoms assessed with the IDAS-II, Profiles #1 and #3, both characterized by greater imbalance between low BAS and high BIS, had lower scores on the wellbeing scale ($M_1 = 2.19$; $SD_1 = 0.75$; $M_3 = 1.54$; $SD_3 = 0.49$) (see Table 4). Furthermore, profile #3 showed greater levels of claustrophobia ($M_3 = 2.67$; $SD_3 = 1.24$), dysphoria ($M_3 = 3.69$; $SD_3 = 0.70$), insomnia ($M_3 = 3.64$; $SD_3 = 1.20$), panic ($M_3 = 3.14$; $SD_3 = 0.99$), and social anxiety symptoms ($M_3 = 2.79$; $SD_3 = 1.19$) relative to the other groups. In the case of the wellbeing scale, there were also differences between profiles #1 and #3 with the latter showing lower scores. Relative to the other profiles, profile #2 showed lower scores on most internalizing symptoms scales, namely, claustrophobia ($M_2 = 1.70$; $SD_2 = 1.05$), social anxiety ($M_2 = 1.84$; $SD_2 = 0.77$), panic ($M_2 = 2.19$; $SD_2 = 1.06$), and mania ($M_2 = 2.46$; $SD_2 = 1.06$), as well as higher scores on wellbeing ($M_2 = 2.79$; $SD_2 = 0.94$). Profile #4 (low ECS, high BAS, and high BIS) showed greater scores on both symptoms of mania ($M_4 = 3.07$; $SD_4 = 0.83$) and euphoria ($M_4 = 2.15$; $SD_4 = 0.82$).

Supplementary Table S1 show higher percentage of patients with disorder diagnoses in profile #3 (Major Depressive Disorder on 76.9%; General Anxiety Disorder on 39.7%; Panic Disorder 26.5). Low prevalence on several disorders precludes comparisons across profiles on all disorders.

3.3. Differences between profiles on quality of life and functionality

With regards to quality of life (SF-36), the imbalanced Profiles #1 and #3 showed generally lower scores relative to the other two groups

Table 2
Latent profile analysis: model fit indices for 2-class to 5-class BIS-BAS-EC patterns, profile prevalences, and kappa estimate for cross-validation.

						Profile prevalence n (%)					
Model	AIC	BIC	SABIC	BRLT (p)	Entropy	1	2	3	4	5	% Kappa
2 class	7423.58	7502.17	7432.42	<0.001	0.750	94 (35.74)	169 (64.25)				0.95
3 class	7340.65	7447.81	7352.70	<0.001	0.796	25 (9.50)	121 (46.00)	117 (44.48)			0.12
4 class	**7275.29**	**7411.03**	**7290.56**	**<0.001**	**0.779**	**117 (44.87)**	**52 (19.77)**	**26 (9.88)**	**68 (25.85)**		**0.94**
5 class	7228.18	7392.50	7246.66	<0.001	0.810	25 (9.50)	111 (42.20)	52 (19.77)	73 (27.75)	2 (0.76)	0.97

Note. The model with best overall fit is shown in bold. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; SABIC = Sample size-adjusted BIC; BLRT (p) = *p*-value for Bootstrapped Likelihood Ratio Test.

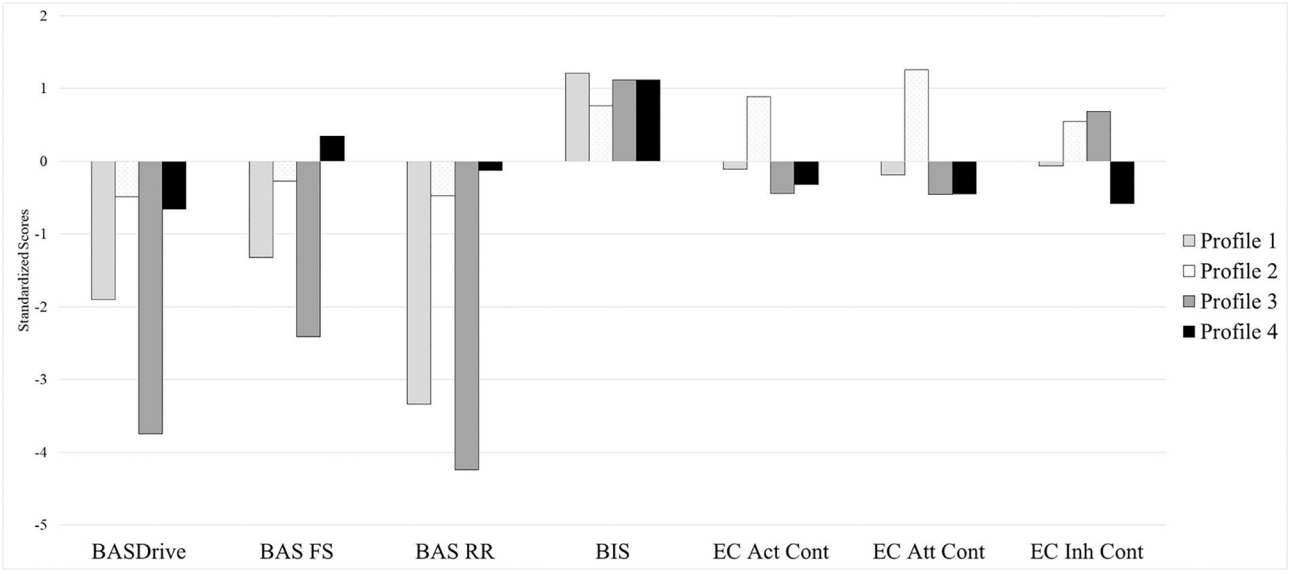

Fig. 1. BIS/BAS EC standardized scores across latent profiles.
Note: Standardization of scores was performed using the normative reference scores for each scale.

Table 3
Differences of BIS/BAS EC standardized scores across latent profiles.

	Reference scores	Profile 1	Profile 2	Profile 3	Profile 4	F / F robust	p	Post-hoc differences and effect sizes	
		n = 117	*n* = 52	n = 26	*n* = 68				
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*			Medium	Large
BAS Drive	13.18 (2.16)$_{1,2,3,4}$	9.07 (1.84)	12.11 (1.56)	5.07 (1.35)	11.75 (2.01)	120.85	<0.001*		1–2, 1–3, 1–4 2–3, 3–4
BAS Fun Seeking	12.55 (2.30) $_{1,3,4}$	9.50 (1.89)	11.92 (1.47)	7.00 (2.28)	13.36 (1.44)	113.55	<0.001*		all
BAS Reward Responsiveness	18.11 (1.84) $_{1,2,3}$	14.77 (1.69)	17.23 (1.64)	10.30 (1.66)	17.88 (1.67)	154.12	<0.001*		1–2, 1–3, 1–4 2–3, 3–4
BIS	19.67 (3.37)$_{1,2,3,4}$	23.78 (3.15)	22.25 (3.28)	23.46 (4.17)	23.45 (3.59)	2.52	0.058		
EC Activation Control	4.17 (0.97) $_{2}$	4.33 (0.90)	5.35 (0.56)	3.99 (1.25)	4.11 (0.98)	39.88	<0.001*		1–2, 2–3, 2–4
EC Attentional Control	3.70 (0.95) $_{1,2,3,4}$	3.17 (0.86)	4.89 (0.86)	2.86 (1.18)	2.87 (0.91)	59.41	<0.001*		1–2, 2–3, 2–4
EC Inhibitory Control	3.95 (0.94) $_{1,2,3}$	4.33 (0.88)	4.98 (0.92)	5.12 (0.98)	3.79 (1.00)	21.54	<0.001*	1–2, 1–4	1–3, 2–4, 3–4

Note. Subindexes refer to the comparison between reference scores and each profile. Bonferroni adjusted p-value <.0071. Effect size: medium (*0.5 < d < 0.8); large (d > 0. 8)*.

(see Table 5). There were also significant differences between them in physical functioning (M_3 = 37.69; SD_3 = 19.99), bodily pain (M_3 = 26.10; SD_3 = 20.01), general health (M_3 = 33.96; SD_3 = 11.85), vitality (M_3 = 19.39; SD_3 = 11.66), and mental health (M_3 = 24.41; SD_3 = 12.19), with profile #3 showing lower scores than #1 in all cases. Profile #4 had lower scores for emotional role (M_4 = 6.61; SD_4 = 14.43). Findings of the WHODAS followed similar patterns, with #1 and #3 showing generally poorer scores. There was also a significant difference between #1 and #3 on life activities (M_3 = 61.53; SD_3 = 33.18), with #3 showing greater dysfunctioning. Profiles #2 and #4 differed on cognition (M_4 = 42.72; SD_4 = 17.77), getting along (M_4 = 32.23; SD_4 = 25.01) and life activities (M_4 = 42.35; SD_4 = 31.86) with the latter showing poorer functioning.

4. Discussion

Transdiagnostic profiles are a promising approach to improve understanding of heterogeneity for people with internalizing disorders and to pave the way towards precision-based interventions. This study identified unique transdiagnostic profiles with temperament measures of three interactive systems of motivation or reactivity and effortful control in a miscellaneous sample of patients enrolled in community mental health treatment. Four distinctive profiles were found, which shared overly increased BIS (as expected in internalizing disorders) and differed on the degree of imbalance between BIS and BAS systems, and specific aspects of effortful control (ECS). These profile-based subtypes also displayed differential psychopathological profiles and subjective quality of life and level of function, illustrating their clinical and real-world significance. Altogether, the newly identified profiles provide prima facie evidence for the existence of transdiagnostic subtypes that can be identified by triangulating measures of BIS, BAS and ECS.

All profiles were high on BIS (similar to the overcontrolled/inhibited profile in Santens et al. [15]), yet different BAS sub-profiles could be identified. Relative to the normative scores, Profile #1 had higher BIS, lower BAS (across the three subscales), and lower Attentional and Inhibitory Control. In this context, this profile could be labelled as “Low overall reward / Reduced self-regulation” (LR/R). The imbalance between low reward-related activation and high punishment-related inhibition, together with difficulties to voluntarily focus or shift attention and inhibit behavior have been theoretically associated with the internalizing spectrum and panic related traits [46]. Profile #2 showed high BIS, but normal scores on BAS fun-seeking and high overall Effortful Control. Despite low reward-related activation and high inhibition, high Effortful Control has been consistently associated with better ability to

Table 4
Differences of internalizing symptoms across latent profiles.

	Reference scores	Profile 1	Profile 2	Profile 3	Profile 4	F / F robust	p	Post-hoc differences and effect sizes		
		n = 117	n = 52	n = 26	n = 68					
Internalizing symptoms	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*			Small	Medium	Large
Appetite gain	1.86 (0.90) $_{1,4}$	2.28 (1.08)	1.84 (1.02)	2.11 (1.08)	2.29 (0.98)	2.47	0.062			
Appetite loss	1.52 (0.73) $_{1,3,4}$	2.30 (1.20)	1.89 (1.04)	2.62 (1.17)	2.22 (1.15)	2.65	0.049			
Checking	1.73 (0.81) $_{1,2,4}$	2.62 (1.07)	2.36 (1.12)	2.46 (1.17)	2.63 (1.02)	0.91	0.435			
Claustrophobia	1.47 (0.73) $_{1,3,4}$	2.25 (1.21)	1.70 (1.05)	2.67 (1.24)	1.86 (0.94)	5.95	<0.001*	1–2	3–4	2–3
Cleaning	1.77 (0.64)	1.86 (0.81)	1.59 (0.78)	2.02 (1.07)	1.84 (0.93)	1.85	0.144			
Dysphoria	1.92 (0.74) $_{1,2,3,4}$	3.40 (0.71)	2.67 (0.83)	3.69 (0.70)	3.10 (0.79)	15.14	<0.001*		3–4	1–2, 2–3, 2–4
Euphoria	1.57 (0.64) $_{4}$	1.58 (0.61)	1.81(0.78)	1.45 (0.55)	2.15 (0.82)	10.53	<0.001*		1–4	3–4
Ill temper	1.78 (0.79) $_{1,2,3,4}$	2.68 (1.04)	2.28 (1.02)	2.39 (0.98)	2.78 (1.01)	2.96	0.033			
Insomnia	2.00 (0.90) $_{1,3,4}$	3.19 (1.12)	2.47 (1.20)	3.64 (1.20)	2.89 (1.03)	7.96	<0.001*		1–2, 3–4	2–3
Lassitude	1.86 (0.71) $_{1,2,3,4}$	2.74 (0.77)	2.37 (0.79)	2.69 (0.58)	2.66 (0.82)	2.88	0.036			
Well-being	2.80 (0.73) $_{1,3}$	2.19 (0.75)	2.79 (0.94)	1.54 (0.49)	2.58 (0.68)	28.91	<0.001*		1–2, 1–4	1–3, 2–3, 3–4
Mania	1.69 (0.74) $_{1,2,3,4}$	2.82 (0.89)	2.46 (0.88)	2.65 (1.03)	3.07 (0.83)	4.94	0.002*		2–4	
Ordering	1.94 (0.74) $_{1,4}$	2.36 (0.89)	2.23 (0.87)	1.90 (0.83)	2.33 (0.89)	2.01	0.114			
Panic	1.44 (0.62) $_{1,2,3,4}$	2.65 (0.94)	2.19 (1.06)	3.14 (0.99)	2.50 (0.94)	6.12	<0.001*	1–2	3–4	2–3
Social anxiety	1.57 (0.69) $_{1,3,4}$	2.64 (1.08)	1.84 (0.77)	2.79 (1.19)	2.58 (0.94)	12.37	<0.001*			1–2, 2–3, 2–4
Suicidality	1.21 (0.48) $_{1,3,4}$	1.66 (0.77)	1.48 (0.88)	1.91 (0.81)	1.48 (0.63)	2.67	0.048			
Traumatic avoidance	1.94 (0.93) $_{1,2,4}$	2.73 (0.90)	2.65 (1.08)	2.34 (0.99)	2.94 (0.93)	2.69	0.046			
Traumatic intrusions	1.51 (0.75) $_{1,2,3,4}$	2.78 (1.09)	2.35 (1.16)	2.94 (1.24)	2.79 (1.18)	2.30	0.077			

Note. Subindexes refer to the comparison between reference scores and each profile. Bonferroni adjusted p-value <.0027. Effect size: small (*0.2 < d < 0.5);* medium (*0.5 < d < 0.8); large (d > 0. 8).*

Table 5
Differences of SF-36 and WHODAS scales across latent profiles.

	Profile for which the score is different from the reference score*	Profile 1	Profile 2	Profile 3	Profile 4	F / F robust	p	Post-hoc differences and effect sizes		
		n = 117	n = 52	n = 26	n = 68					
SF-36 domains		*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*			Small	Medium	Large
Physical Functioning	2	49.43 (15.25)	56.47 (13.86)	37.69 (19.99)	54.26 (15.55)	7.66	<0.001*	1–2	1–3	2–3, 3–4
Role Physical	1, 2, 3, 4	11.32 (17.60)	17.78 (20.76)	10.09 (20.00)	16.54 (19.60)	2.10	0.106			
Bodily Pain	3	45.50 (25.61)	48.40 (23.98)	26.10 (20.01)	48.47 (24.86)	5.90	<0.001*			1–3, 2–3, 3–4
General Health	1, 3, 4	36.20 (14.75)	47.78 (18.08)	23.96 (11.85)	42.80 (16.70)	19.17	<0.001*	1–4	1–2	1–3, 2–3, 3–4
Vitality	1, 2, 3, 4	28.16 (11.76)	38.72 (14.96)	19.39 (11.66)	34.31 (12.36)	17.30	<0.001*		1–2, 1–3, 1–4	2–3, 3–4
Social Functioning	1, 2, 3, 4	38.63 (10.89)	42.69 (9.52)	34.23 (13.61)	39.10 (12.99)	3.30	0.021			
Role Emotional	1, 2, 3, 4	4.41 (10.35)	14.74 (17.66)	5.76 (14.09)	6.61 (14.43)	5.11	<0.001*		1–2, 2–3, 2–4	
Mental Health	1, 2, 3, 4	31.34 (11.53)	38.93 (14.73)	24.41 (12.19)	36.17 (11.02)	13.00	<0.001*		1–2, 1–3, 1–4	2–3, 3–4
WHODAS domains										
Cognition	2, 4	44.70 (22.26)	27.88 (20.27)	53.46 (24.36)	42.72 (17.77)	11.04	<0.001*		1–2, 2–4	2–3,
Mobility	1, 2, 4	32.90 (26.22)	19.59 (24.00)	46.75 (33.17)	25.37 (22.84)	6.32	<0.001*		1–2, 3–4	2–3
Self-Care	1, 2, 3, 4	22.82 (22.54)	10.76 (19.78)	30.38 (23.91)	17.64 (19.78)	6.09	<0.001*		1–2	2–3
Getting-along	1, 2, 4	41.24 (24.51)	17.32 (17.06)	51.92 (29.65)	32.23 (25.01)	21.69	<0.001*		2–4, 3–4	1–2, 2–3,
Life Activities	2	43.62 (29.82)	24.42 (28.38)	61.53 (33.18)	42.35 (31.86)	9.41	<0.001*		1–2, 1–3, 2–4, 3–4	2–3,
Participation	2	48.06 (20.57)	37.09 (20.10)	59.45 (23.23)	45.58 (21.49)	6.96	<0.001*		1–2, 3–4	2–3,
Total (32 ítems)	1, 2, 4	40.48 (17.37)	25.56 (15.76)	51.73 (21.55)	36.42 (16.08)	13.97	<0.001*		1–3, 2–4	1–2, 2–3, 3–4

Note. [a] Reference scores for SF-36 and WHODAS domains are M = 50; SD = 10 (i.e normal distribution). Bonferroni adjusted p-value <.0063; Effect size: small (*0.2 < d < 0.5);* medium (*0.5 < d < 0.8); large (d > 0. 8).*

adaptively modulate reward and punishment sensitivity and thus with more preserved mental health [15]. According to this, profile #2 could be identified as "Normal fun-seeking / Protective self-regulation" (FS_{normal}/P). Profile #3 featured high BIS, lowest BAS, and lower Attentional Control but higher Inhibitory Control. In this particular setting, profile #3 could be then referred to as "Low overall reward / Mixed self-regulation" (LR/M). Similarly to profile #1, the imbalance between activation and inhibition and the reduced attentional control

have been linked to the internalizing spectrum although relatively high inhibitory control may suggest fear and restraint-related characteristics [47]. Profile #4 was characterized by higher BIS but higher fun seeking and lower Attentional Control compared to the normative scores, as well lower Inhibitory Control -relative to the other three profiles-. The distinctive high levels of fun seeking and low levels of Inhibitory Control aligned with internalizing / mania and externalizing / disinhibition characteristics [47,48], and led to label the profile as "High fun seeking / Reduced self-regulation" (FS_{high}/R).

Indeed, when analyzing the relationship of each of these profiles with psychopathological symptoms, profiles #1 and #3 characterized by greater unbalance between inhibition (high) and reward reactivity (low), were the ones showing greater symptoms associated with fear, anxiety and somatization, as well as generally lower levels of function, with profile #3 even showing less wellbeing than #1. These profiles show a "triadic disequilibrium" in which reduced reward reactivity, enhanced sensitivity to external and internal threats, and difficulties to re-focus or shift attention can be linked to higher severity and chronicity of psychopathology, as shown in specific disorders such as anorexia and schizophrenia [21,22]. Furthermore, we found that the profile #3 (Low overall reward / Mixed self-regulation) (characterized by lowest reward reactivity and a decompensated self-regulation (high in inhibitory control but low in attentional control) showed a combination of mood-related symptoms along with anxiety-related symptoms (e.g. claustrophobia, panic and social anxiety symptoms), and lower levels of quality of life concerning emotional roles, being a internalizing more over-controlling profile [27]. Finally, the reward differential features (higher fun seeking but lower reward drive) of profile #4 (High fun seeking / Reduced self-regulation), together with high BIS, and poor ECS were consistent with a psychopathological profile featuring increased mania, dysphoria and euphoria. These features suggest this profile is associated with disinhibition traits and mania-related symptoms [49].

The identified profiles also partly align with the subtypes identified through latent profile analysis using the National Comorbidity Survey datasets (Profile #2 and profile #3 are similar to the "few-disorder class" and the "multimorbid class" respectively [50,51]). However, patients displaying manic symptomatology were classified within the multimorbid group latent profile, cooccurring with high levels of psychopathology, while our results identified a separate group for patients showing mania-related characteristics (i.e., Profile 4). Since the profile grouping variables in our study were trait-based reactivity and control systems, and not symptom-based variables, it seems plausible that these dispositional variables contribute to greater specificity to identify and explain comorbidity patterns.

Our findings are consistent with those of previous studies examining the association between BAS, BIS and Effortful Control constructs and psychopathology (reviewed in Santen et al. [15]). For example, we showed that high Effortful Control has a protective or buffering role on psychopathology, even when motivational systems are altered. We also showed that high BIS and low BAS are common features of the internalizing spectrum, and that greater imbalance between them is associated with greater psychopathology. The findings also resonate with previous research [15,19] showing that elevated temperamental reactivity can segregate into different subtypes of affective disorder, and that lower functioning of effortful control systems is associated with more debilitating phenotypes. Notwithstanding the alignment with previous studies on specific patient groups [21,26,28,29], our findings go beyond available evidence by showing how temperament-based profiles cut across and dissect heterogeneity among different mental disorders from a transdiagnostic triadic models perspective [18]. On the other hand, we should note that some profiles show overlapping features regarding specific constructs (e.g. high BIS, low Attentional Control) and psychopathology (e.g. only one internalizing symptom is different between the two Low overall reward profiles). Conversely, some facets of ECS did not contribute to profile differences. These issues highlight there is still potential for more precise measures that when applied to diverse samples can yield greater granularity and specificity [52].

Based on our findings, the identified profiles may be clinically useful for the assessment, characterization, and triage of patients seeking treatment for internalizing mental illness in at least three ways. Firstly, they segregate preserved fun seeking (#2 and #4) versus overall low reward profiles (#1 and #3), with the latter pair (i.e., characterized by low BAS and thus reward-scarcity) showing poorer mental health and quality of life. Secondly, they identify profiles with reduced levels of attentional control (#1, #3 and #4, the latter also showing reduced inhibition), likely displaying poorer regulation of cognitive resources and emotions. Uncontrolled profiles are also probably more vulnerable to perceived hopelessness, which emerges as result of poor alignment between intentions, behaviors and outcomes [53]. These characteristics may contribute to experiencing reduced quality of life and limited participation in emotional roles. Finally, the profiles reveal unique psychopathological profiles, clearly illustrated by differences between #1 & #3 (linked to anxiety and somatization) versus #4 (linked to affective dysregulation). Altogether, these clinically relevant profiles could be identified by treatment providers during intake to guide triage for treatment targets and provide clinical management in an evidence-based and timely manner.

Our findings also offer pragmatic implications for treatment selection and customised interventions. Theoretically, the identified profiles could be used to apply profile-matched tailored interventions. First, given ECS is a general protective factor for psychopathology, in patients with a profile with low ECS a first treatment focus could be to enhance cognitive top-down regulatory processes. This might be done with neurocognitive interventions, who could be beneficial to increase the level of resilience, reduce the prevalence of psychopathology and improve well-being. [54]. Second, behavioral activation can also be a focus when levels are too low. This is a specific skill that can be addressed by Cognitive Behavior Therapy [55]. and that can alleviate depression and anxiety symptoms. This implies we would need new prognostic research to ascertain if the identified profiles can predict treatment outcomes over and above current assessment approaches, and/or in a more cost-effective way by focusing on shared factors such as low ECS, and/or low BAS. If so, tailored interventions matched to each of the profiles could be purpose-built based on existing evidence-based strategies, and the resulting personalized treatment packages tested in clinical trials [56]. Summarized, research evidence integrating temperament, psychopathology and neural/etiological bases into clinical practice can thus probably improve the assessment and treatment of patients by pinpointing transdiagnostic targets [57].

5. Limitations and future directions

Despite the promising findings, it is important to acknowledge certain limitations. Firstly, the sample, consisting of mental health service patients, was not selected through a probabilistic procedure. Although we did not keep a record of reasons for exclusions, clinicians involved in recruiting the participants reported during coordination meetings that the discrepancy between the patients who participated and those who did not was primarily due to their availability to complete the interview at the times offered. Although availability was a situational factor (i.e., related to timetable clashes or unforeseen appointments), and thus unlikely to have a systematic impact on the outcomes that we measured, the lack of comparison between study responders and non-responders remains a limitation of our study. Similarly, while there is a statistically significant higher proportion of women in the participating sample, this is reflective of the usual higher proportion of female users of community mental health care services at the population level [58]. Similarly, this proportion also reflects proportionally the differential prevalence of internalizing disorders between men and women [58].

Second, the reliability coefficients estimated as internal consistency through Cronbach's alpha of the CE scales were relatively low in each

subscale (especially that obtained in the inhibitory control scale), although acceptable for the overall scale. This result is consistent with values observed in other studies [15,59]. However, other authors have found that when reliability is estimated as a test-retest, reliability coefficients improve markedly (e.g. Totella-Feliu et al. [59]). These results seem to indicate that responses to the dimensions of this instrument appear to be stable.

Furthermore, our findings were cross-sectional, and more research is needed to establish the stability of identified clusters across disorder-related and treatment-related trajectories. In addition, we used RDoC to conceptualize our study, but we only applied temperament-based self-report assessments; future research should validate and expand our findings other measures such as cognitive and biological measures. It would also be useful to ascertain if the identified profiles could serve to discriminate aspects of externalizing psychopathology (i.e., by using externalizing trait measures in samples similar to that of the present study) and to examine whether similar profiles can be pinpointed in samples with a greater representation of externalizing psychopathology.

CRediT authorship contribution statement

A. Verdejo-Garcia: Writing – review & editing, Writing – original draft, Validation, Supervision. **G. Rossi:** Writing – review & editing, Writing – original draft, Validation, Formal analysis, Conceptualization. **N. Albein-Urios:** Writing – original draft, Visualization, Validation, Formal analysis. **O.M. Lozano:** Writing – original draft, Visualization, Validation, Software, Resources, Investigation, Formal analysis. **C. Diaz-Batanero:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Funding acquisition, Conceptualization.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.comppsych.2024.152498.

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