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Research paper

Sensory profiles as a possible mediator between hypomania and hopelessness in 488 major affective outpatients

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ABSTRACT

Introduction: Extreme sensory processing patterns may contribute to the pathophysiology of major affective disorders. We aimed to examine whether significant correlations exist between sensory profiles, hypomania, self-reported depression, and hopelessness and whether sensory profiles may be a significant mediator between hypomania and depression/hopelessness.

Methods: The sample consisted of 488 euthymic affective disorder patients of which 283 diagnosed with unipolar and 162 with bipolar disorder with an age ranging from 18 to 65 years (mean = 47.82 ± 11.67).

Results: Lower registration of sensory input and sensory sensitivity significantly correlated with elevated self-reported depression, hopelessness, and irritable/risk-taking hypomania while sensation seeking and avoiding significantly correlated with elevated depression and hopelessness but not irritable/risk-taking hypomania. Moreover, individuals with lower ability to register sensory input and higher hypomania showed higher self-reported depression than those with good registration. According to SEM analyses, there was both a direct/indirect effect of irritable/risk-taking on depression-hopelessness with the mediation model explaining 48% of the variance in depression-hopelessness.

Limitations: The relatively small sample size and the cross-sectional nature of the study design do not allow the generalization of the main findings.

Conclusion: Low registration was associated with enhanced depressed mood and hopelessness while sensory seeking may be considered as a resilient factor.

1. Introduction

Sensory processing refers to the ability to register/modulate sensory information and organize sensory input in order to respond to situational demands (Humphry, 2002). Extreme sensory processing patterns include hyper- or hyposensitivity to non-aversive stimuli (Miller et al., 2007). Impairments concerning sensory processing have been first described in 1960's and 1970's (Bogdashina, 2003), using the following terms: "sensory dysfunction", "sensory perceptual impairments", and "disturbances of sensory modulation/information processing".

Here, we specifically refer to the model which was proposed by Dunn (1997). This model refers to the relationship between subjective neurological thresholds and behavioural self-regulation strategy (Dunn, 1997; Brown and Dunn, 2002). Individuals with hyposensitivity have higher neurological threshold while those with hypersensitivity have lower neurological threshold. Those who use passive behavioural strategies allow stimuli to occur based on their threshold, while indi-

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viduals using an active behavioural strategy usually counteract their threshold and control the amount/type of sensory input they perceive (Dunn, 1997).

Subjects with sensory processing disorders may be considered as being continuously under sensory overload. As a result, their nervous system is really stressful and shows an important inflexibility together with the inability to modulate stimuli that are perceived as overwhelming, and difficult to manage.

The model proposed by Dunn refers to four patterns of sensory processing with the first two related to hyposensitivity: (1) Subjects with low registration failing to detect sensation and not actively seeking for sensory input (usually described as unmotivated, withdrawn, and inattentive); (2) Individuals who are sensory seekers that commonly enjoy rich sensory environments/activities. Sensation seekers may show impulsivity and risk-taking behaviors. The other two patterns are related to hypersensitivity: (3) Subjects who are sensory sensitive and feel discomfort with regular sensations but they do not actively restrict their exposure to uncomfortable stimuli; (4) individuals who are sensation avoiders and are usually described as introspective as they actively limit the exposure to sensory information. When sensory processing patterns do not impair with daily life activities, they may be considered individual/specific trait characteristics.[6] However, when they are extreme and significantly interfere with psychosocial functioning and/or participation/involvement in daily life, they need to be considered as sensory processing disorders (SPD) (Miller et al., 2007; Dunn, 2001).

Sensory processing problems are generally not recognized as factors involved in the negative outcome of psychiatric conditions nor mentioned as differential diagnoses able to negatively impact on the illness course although significantly affecting psychosocial functioning and determining emotional instability. For instance, major affective disorders are worldwide associated with long-term disability, psychosocial impairment, and poor intervention outcomes including suicidal behavior (Pompili et al., 2011, 2012) but the involvement of impairments regarding emotional processes or sensory processing has been only marginally hypothesized and not systematically addressed in the pathophysiology of these conditions (Van Rheenen and Rossell, 2013; Leitman et al., 2010). Conversely, SPD appear to share important clinical similarities with major affective disorders (e.g., some of the criteria for juvenile bipolar disorder, specifically the item five of the 'Core Phenotype – Research Diagnostic Criteria' for juvenile bipolar disorder) (Papolos, 2005).

Overall, consistent evidence indicated that subjects with unipolar/bipolar disorders are impaired in their ability to process sensory environmental information but these subjects, who presumably represent a subgroup at higher risk in terms of outcome are clinically not adequately recognized. Extreme sensory processing patterns have been proposed as a stable dimension able to characterize individuals with major affective disorders (Engel-Yeger et al., 2016a, 2016b). Indeed, subjects with extreme sensory processing patterns frequently presented impairments in modulating emotional/behavioural responses. Sensory processing disorders may be considered as a leading cause of disability in major mood disorders, especially the hypo-sensitive pattern of low registration which is associated with enhanced depressed mood in specific subtypes of major affective disorders (Engel-Yeger et al., 2016a).

It is also well known that the careful evaluation of previous hypomania episodes in individuals with major affective disorders needs specific attention and even caution in psychiatric practice (Maj et al., 2002). Subjects do not always perceive hypomania as pathological, and, as a result, they do not spontaneously report it in the current clinical practice (Scott, 2001). Thus, the correct recognition of hypomanic episodes is abnormally delayed altering the appropriate diagnostic identification (Baldessarini et al., 2010). To this regard, it is well known that subjects with bipolar disorder (BD) often report that, although their symptoms occur early in life, the adequate diagnosis is usually delayed of approximately ten years (Hirschfeld et al., 2003). Misdiagnosis in BD is a very relevant public health problem as it is usually associated with delayed therapeutic interventions and unfavorable treatment outcomes. Untreated hypomania is commonly associated with financial, legal, occupational, and psychosocial problems (Yatham et al., 2013). Thus, the periodic screening of hypomanic symptoms in subjects presenting atypical depressive episodes may be crucial for the early detection and adequate BD treatment. Hypomania is also associated with impulsive decision-making and risk-taking behavior that may arise from hypersensitivity to reward and early influence of attention on reward processing, providing support for reward dysregulation in major affective disorders (Mason et al., 2012).

Furthermore, major affective disorders are worldwide associated with poor intervention outcomes including suicidal behavior (Pompili et al., 2011, 2013). According to cognitive assumptions, suicidal behavior has been conceptualized as an exit of hopelessness/despair (Minkoff et al., 1973). Hopelessness has been proposed as a pessimistic cognitive structure for the future and identified as an independent predictor of suicidal behavior (Pompili et al., 2013). Unfortunately, there are no studies in the current literature investigating the specific relation between extreme sensory processing patterns/SPD and hopelessness neither studies addressing the complex interaction between sensory processing patterns/SPD, hypomania, and self-reported depression during emotion processing.

Thus, the present manuscript is mainly aimed to: (1) examine whether significant correlations exist between extreme sensory processing patterns, hypomania, self-reported depression, and hopelessness; (2) investigate whether sensory profiles are a significant mediator between hypomania and depression/hopelessness.

We mainly hypothesized that: 1) individuals with specific sensory processing patterns (the hypo-sensitive pattern of low registration) might exert higher hypomanic symptoms (evaluated using the hypomania checklist) and higher hopelessness (assessed using Beck Hopelessness Scale) as well as 2) sensory profiles may significantly mediate the relation between hypomania and depression/hopelessness.

2. Methods

2.1. Participants and procedure

The sample consisted of 488 currently euthymic affective disorder patients of which 283 diagnosed with unipolar and 162 with bipolar disorder (43 missing cases) with an age ranging from 18 to 65 years (mean = 47.82 ± 11.67). Participants were distributed as follows when admitted: 63.1% of subjects were diagnosed with unipolar major depressive disorder (MDD), 16.2% with bipolar disorder type I (BD-I), and 20.7% type II (BD-II). They were all consecutive outpatients receiving only maintenance treatment that have been followed by our university outpatient service for at least 12 months. Specifically, their psychoactive medication regimens and their psychopathological conditions were stable for at least 6 months.

All participants were admitted to the Department of Neuroscience (DINOGMI), University of Genoa, outpatient service, between July 2014 and April 2016. The inclusion criterion was a diagnosis of major affective disorders such as MDD, BD-I, and BD-II as specified. Exclusion criteria were any condition affecting the ability to fill out the assessment including delirium, dementia or any severe neurological diseases including mental retardation, and denial of the informed consent. Diagnostic criteria were based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, TR) (American Psychiatric Association, 2001). Psychiatric histories were carefully collected by clinical psychiatrists and psychologists (GS and GC) and later verified using the Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1998). All patients accepted voluntarily to participate in the study and gave

their informed consent. The study design was approved by the local Ethical Review Board. Participants' socio-demographic information have been summarized in Table 1.

2.2. Measurements

2.2.1. The Adolescent/Adult Sensory Profile (AASP)

The AASP (Brown and Dunn, 2002) is a self-report psychometric tool with 60 items, including questions pertaining to each of the sensory systems. The items are sorted equally into four traits reflecting the Dunn's model: Low Registration (e.g., "I miss the street, building or room signs when trying to go somewhere new"), Sensation Seeking (e.g., "I like to go to places that have bright lights and that are colourful"), Sensory Sensitivity (e.g., "I am uncomfortable wearing certain fabrics…") and Sensation Avoiding (e.g., "I avoid elevators and/or escalators because I dislike the movement"). The four traits described on the AASP categories were statistically derived by factor analysis and the results were consistent with the *a priori* hypothesis of the quadrant model (Dunn, 1997).

Participants indicate the frequency of their behavioural responses to sensory experiences in daily life on a five-point Likert scale. Norms exist for various age groups (11–17; 18–64; 65 and above). Good psychometric properties have been demonstrated for this questionnaire (Pohl et al., 2003).

In the present study, the five ranges for each sensory processing pattern, as presented in the AASP manual, were merged as follows: "Less than most people" represents approximately 16% of the population (one standard deviation (SD) below the mean); (2) "Similar to most people" represents the normal range which was found among approximately 68% of the population (between − 1 SD and + 1 SD); (3) "More than most people" represents approximately 16% of the population (or more than 1 SD above the mean). The AASP is currently under validation in Italian language.

2.2.2. The second version of the Beck Depression Inventory (BDI-II)

The BDI-II (Beck et al., 1996) is a 21-item self-report questionnaire which was commonly used to assess the severity of depressive symptoms in the two weeks prior to the questionnaire completion. The questionnaire score is the sum of these items and ranges from 0 to 63. Higher scores reflect higher severity of symptoms. Mean values have been obtained through the Italian validation study of Sica and Ghisi (2007) on a population of 723 undergraduate students (343 males with a mean age of 21.7 years; SD = 1.6; range 19–31 years, and 380 females with a mean age of 20.98 years; SD = 2.66; range 18–36 years) of which 72 depressed individuals (74% females with a mean age of 21.1 years; SD = 2.1) were compared with 72 subjects who were randomly selected from the initial sample of 723 college students (Sica and Ghisi, 2007).[30] The mean BDI-II score was 8.23 consistent with minimal depression (Beck et al., 1996).

2.2.3. Hypomania Checklist (HCL-32)

The HCL-32 is a 32-item self-report questionnaire which has been specifically developed to identify hypomanic symptoms in patients with major depressive episodes (Angst et al., 2005). It has been used as a screening instrument for BD and bipolar spectrum disorders in many clinical settings (Carta et al., 2006). Subjects with a total score of 14 or more are potentially bipolar and should be carefully interviewed. Two factors were derived by the 32 items of this psychometric instrument which were later replicated both in patient and general population samples and were labeled "active/elated" and "irritable/risk-taking". The sum of the following items: 2, 3, 4, 5, 6, 10, 11, 12, 13, 15, 16, 19, 20, 22, 24, and 28 forms the dimension "active/elated" with a sum score of 12 or higher may indicate the presence of an "active/elated hypomania". In addition, the sum of the following items: 7, 8, 9, 21, 25, 26, 27, 31, and 32 forms the dimension "irritable/risk-taking" with a sum score of 3 or higher may indicate the presence of an "irritable/risk-taking hypomania" (Angst et al., 2005).

2.2.4. Beck Hopelessness Scale (BHS)

The BHS is a 20-item self-report psychometric instrument for assessing negative attitudes about the future (Beck and Steer, 1989; Beck et al., 1974). This scale specifically addressed feelings about the future, loss of motivation and expectations. Research supports a significant association between BHS scores, depression, suicidal intent, and current suicidal ideation. We considered the BHS cutoff score of 9 or higher to define individuals at suicide risk (Beck et al., 1990).

2.3. Statistical analyses

All the analyses were performed using the Statistical Package for Social Sciences (SPSS) for Windows 21.0. The correlations between all dependent variables were examined by Pearson correlation test.

Chi square analysis was performed to examine whether significant difference exists in the prevalence of extreme sensory processing patterns between participants with higher hypomania and higher suicidal risk. MANOVA with Bonferroni post hoc examined the significance of differences in depression between groups.

Structural Equation Modeling (SEM) (Byrne, 2001) was used to examine whether sensory profiles are a significant mediator between hypomania and depression/hopelessness. The following different fit indices were tested: the Goodness-of-Fit Statistic, Goodness-of-Fit Index (GFI), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Standardized RMR, and Comparative Fit Index (CFI). Chi-square was used for nested models comparison. Finally, P values ≤ .05 were considered statistically significant.

3. Results

3.1. Clinical profile of the recruited sample

Table 1 depicts the socio-demographic information together with the clinical profile of the participants as measured by the ranges, mean, and standard deviation scores regarding depression, hopelessness, and hypomania. The sensory processing performance ranges of the total sample are also reported in Table 1.

3.2. Socio-demographic differences between subjects with different sensory processing patterns

No specific socio-demographic differences have been reported between subjects with different sensory processing patterns. In particular, no significant differences emerged in terms of age of onset, duration of untreated illness, and total duration of illness in years. Socio-demographic and clinical differences between subjects with different sensory processing patterns are summarized in Table 1.

3.3. Correlations between sensory processing patterns, depression severity, hypomania, and hopelessness (total score and subscales)

As presented in Table 2, lower registration and sensory sensitivity significantly correlated with elevated depression, hopelessness, and irritable/risk-taking hypomania. Sensation avoiding significantly correlated with elevated self-reported depression and hopelessness. Conversely, sensory seeking did not significantly correlated with any of the mentioned dependent variables.

Table 1
Participants' socio-demographic and clinical information and ranges, mean and SD scores of depression, hopelessness, and hypomania measures in the analyzed sample (N = 488).

		N	Percent	Ranges	Mean	SD[a]
Gender	Male	186	38.1			
	Female	302	61.9			
Level of education	Elementary schools	15	3.1			
	Junior high schools	145	29.7			
	Secondary schools	243	49.8			
	Academy	61	12.5			
	Missing cases	43	4.9			
Marital status	Single	159	32.6			
	Married	215	44.1			
	Divorced	78	16.0			
	Widowed	16	3.3			
	Missing cases	20	4.1			
Living with	Alone	99	20.3			
	Family	350	71.7			
	Friend	19	3.9			
	Missing cases	20	4.1			
Employment	Employed	290	59.4			
	Unemployed	120	24.6			
	Retired	40	8.2			
	Students	17	3.5			
	Missing cases	21	4.3			
Socio-economic status	Below average	170	34.8			
	Average	255	52.3			
	Above average	42	8.6			
	Missing cases	21	4.3			
Illness duration in years				.2–60	10.45	12.64
Age at first psychiatric treatment				8–65	39.73	13.43
Age of illness onset				5–65	39.42	14.33
BDI-II				0–55	21.05	12.68
Minimal depression		146	29.9			
Mild depression		59	12.1			
Moderate depression		107	21.9			
Severe depression		126	25.8			
Missing cases		50	10.2			
BHS				0–20	9.74	5.61
0–3		67	13.7			
4–8		124	25.4			
≥ 9		226	46.3			
Missing cases		71	14.5			
HCL-32				0–29	13.44	6.06
Hypomania	Yes	187	38.3			
	No	175	35.9			
	Missing cases	126	25.8			
Active/elated hypomania				0–16	8.77	4.73
	Yes	241	49.4			
	No	121	24.8			
	Missing cases	126	25.8			
Irritable/risk-taking				0–7	1.73	1.58
	Yes	250	51.2			
	No	111	22.7			
	Missing cases	127	26.0			
Low registration	Under norm	107	21.9	15–23[a]		
	Norm	172	35.2	24–35[a]		
	Above norm	117	24.0	36–75[a]		
	Missing cases	92	18.9			
Sensory seeking	Total sample			15–70[b]	30.52	9.93
	Under norm	295	60.5	15–42[a]		
	Norm	91	18.6	43–56[a]		
	Above norm	8	1.6	57–75[a]		
	Missing cases	94	19.3			
Sensory sensitivity	Total sample			15–63[b]	36.46	9.26
	Under norm	65	13.3	15–25[a]		
	Norm	202	41.4	26–41[a]		
	Above norm	127	26.0	42–75[a]		
	Missing cases	94	19.3			
Sensory avoidance	Total sample			15–68[b]	36.44	11.01
	Under norm	79	16.2	15–26[a]		
	Norm	191	39.1	27–41[a]		
	Above norm	126	25.8	42–75[a]		

Table 1 (*Continued*)

		N	Percent	Ranges	Mean	SD[a]
	Missing cases	92	18.9			
	Total sample			15–66[b]	35.91	10.92

Note: BDI-II = Beck Depression Inventory-second version; BHS = Beck Hopelessness Scale; HCL-32 = Hypomania checklist; SD = Standard deviation.
[a] Sensory performance ranges according to the AASP manual.
[b] Sensory performance ranges of study's participants.

3.4. Differences among individuals with specific sensory processing patterns in terms of hopelessness

As presented in Table 3, *Chi* square analysis revealed that the prevalence of low registration above norm was significantly higher among participants with BHS ≥ 9 (χ^2 = 26.41, p < .0001). A similar trend was found in regard to sensory sensitivity (χ^2 = 39.58, p < .0001) and avoidance (χ^2 = 15.16, p < .0001). No significance was found between the groups when referring to sensory seeking (χ^2 = 2.05, p = .36).

3.5. Differences among individuals with specific sensory processing patterns and hypomania

We divided our participants into four groups: those with no hypomania; those with reduced sensory processing patterns and hypomania; those with normal sensory processing patterns and hypomania; and those with extreme sensory processing patterns and hypomania.

When referring to low registration pattern, significant differences were found regarding self-reported depression level between the groups ($F_{3,339}$ = 10.45, p < .0001): participants with hypomania and lower registration (above norm) had significant higher self-reported depression than those with no hypomania (mean difference = 9.38, p < .0001); those with hypomania and no tendency for low registration (under norm) (mean difference = 12.77, p < .0001); and those with hypomania and normal registration (mean difference = 8.47, p = .001).

When referring to sensation seeking pattern: no significant differences were found concerning self-reported depression between the groups ($F_{3,319}$ = 1.19, p = .32).

When referring to sensory sensitivity pattern, significant differences were found regarding self-reported depression between the groups ($F_{3,325}$ = 7.30, p < .0001): participants with hypomania and greater sensitivity (above norm) had significant higher self-reported depression than those with no hypomania (mean difference = 7.66, p < .0001); those with hypomania and sensitivity under norm (mean difference = 11.61, p = .001); and those with hypomania and normal sensitivity (mean difference = 7.14, p = .004).

When referring to sensory avoidance pattern, significant differences were found concerning self-reported depression between the groups ($F_{3,326}$ = 12.21, p < .0001): participants with hypomania and greater avoidance (above norm) had significant higher depression than those with no hypomania (mean difference = 8.57, p < .0001); those with hypomania and avoidance under norm (mean difference = 15.14, p < .0001); and those with hypomania and normal avoidance (mean difference = 7.76, p = .001).

3.6. Differences among individuals with specific sensory processing patterns and self-reported depression

We divided our participants into four groups: those without hopelessness (BHS < 9); those with reduced sensory processing patterns and hopelessness (BHS ≥ 9); those with normal sensory processing patterns and hopelessness (BHS ≥ 9); and those with extreme sensory processing patterns and hopelessness (BHS ≥ 9).

When referring to low registration pattern, significant differences were found concerning self-reported depression between the groups ($F_{3,398}$ = 76.84, p < .0001): participants with hopelessness and lower registration (above norm) had significant higher depression than all other groups.

When referring to sensory seeking pattern, significant differences were found regarding self-reported depression between the groups ($F_{3,398}$ = 58.34, p < .0001): participants with no hopelessness had significant lower depression than all other groups.

When referring to sensory sensitivity pattern, significant differences were found regarding self-reported depression between the groups ($F_{3,398}$ = 72.51, p < .0001): participants with hopelessness and greater sensitivity (above norm) had significant higher self-reported depression than those without hopelessness (mean difference = 18.23, p < .0001); those with hopelessness and sensitivity under norm (mean difference = 11.67, p < .0001); and those with hopelessness and normal sensitivity (mean difference = 7.54, p < .0001).

When referring to sensory avoidance pattern, significant differences were found concerning self-reported depression between the groups ($F_{3,398}$ = 67.19, p < .0001): participants without hopelessness had significant lower depression than all other groups. Table 4 summarizes means and standard deviations of depression and hopelessness level, in patients with/without hypomania in the different sensory performance ranges.

As presented in Table 2, a high significant correlation was found between BDI total score and hopelessness score (r = .65, p < .0001). This supports the reported relation between elevated depression and higher hopelessness. Thus, SEM analysis referred to both variables as one latent variable (named "depression-hopelessness" in Fig. 1).

The results of the SEM analysis showed that the factor loadings for the indicators of depression-hopelessness variable and the variables of the sensory profile were significant and acceptable in size (all loadings are > .7). The SEM model revealed good fit indices: χ^2 (7) = 18.01, p = .012; CFI = .985; TLI = .968, RMSEA = .07, SRMR = .03.

There was a direct effect between irritable/risk-taking and depression-hopelessness (β = .14, p = .008). Participants with higher irritable/risk-taking were more likely to report greater sensory processing difficulties (SPD) (β = .23, p < .001). Moreover, participants with greater sensory processing difficulties reported higher depression-hopelessness (β = .65, p < .001) (see Fig. 1). The indirect effect of irritable/risk-taking to depression-hopelessness through SPD was significant (p = .001). The mediation model explains 48% of the variance of depression-hopelessness.

4. Discussion

4.1. Correlations between sensory processing patterns and the investigated clinical variables

We were particularly interested in understanding whether patients who exhibit major affective disorders and certain sensory profiles may also present higher hypomania, self-reported depression, and hope-

Table 2
Correlations between sensory processing patterns, depression severity, hypomania, and hopelessness.

Questionnaire/sensory profile	BDI-II	BHS hopelessness	Hypomania	active/elated hypomania	irritable/risk-taking	Low Registration	Sensation Seeking	Sensory Sensitivity	Sensation Avoiding
BDI-II	1	.65***	NS	NS	.27***	.46***	NS	.48***	.39***
BHS hopelessness	.65***	1	NS	NS	NS	.35***	NS	.43***	.31***
Hypomania	NS	NS	1	.89***	.39***	NS	.21***	NS	NS
active/elated hypomania	NS	NS	.89***	1	NS	NS	NS	NS	NS
irritable/risk-taking	.27***	NS	.39***	NS	1	.27***	NS	.21***	NS
Low Registration	.46***	.35***	NS	NS	.27***	1	NS	.66***	.65***
Sensation Seeking	NS	NS	NS	NS	NS	NS	1	NS	NS
Sensory Sensitivity	.48***	.43***	NS	NS	.21***	.66***	NS	1	.72***
Sensation Avoiding	.39***	.31***	NS	NS	NS	.65***	.22***	.72***	1

*** $p \leq .001$.

Table 3
Percentage of participants with/without hopelessness in each sensory processing performance range (N = 382).

		No hopelessness (BHS < 9)	Hopelessness (BHS ≥ 9)	$\chi_{(2)}^2$
Low registration	Under norm	36.3	16.6	26.41***
	Norm	44.4	44.5	
	Above norm	19.3	38.9	
Seeking	Under norm	71.8	77.3	2.05
	Norm	26.5	20.4	
	Above norm	1.7	2.4	
Sensory sensitivity	Under norm	25.3	7.6	39.58***
	Norm	56.5	48.3	
	Above norm	18.2	44.1	
Sensory avoidance	Under norm	24	14.2	15.16***
	Norm	53.8	46	
	Above norm	22.2	39.8	

*** $p \leq .001$.

lessness and whether specific sensory profiles may be a significant mediator between hypomania and depression/hopelessness in our sample.

As we initially hypothesized, we found interesting correlations between the investigated clinical variables. First, we found that lower registration and sensory sensitivity significantly correlated with elevated depression, hopelessness, and irritable/risk-taking hypomania while sensation avoiding significantly correlated with elevated self-reported depression and hopelessness but not irritable/risk-taking hypomania. Aron and Aron (1997) demonstrated the existence of a unidimensional construct of high sensory sensitivity (and associated arousability) which was partially independent of introversion and emotionality according to their assumptions. They supposed that high sensitivity in itself appeared to have broad implications in terms of both behavior and experience. In particular, they hypothesized that sensory-processing sensitivity may be one of the most relevant factors involved in determining differences underlying the successful survival strategy within species, that are an end product of natural selection.

Based on our results, sensory seeking did not significantly correlated with any of the mentioned dependent variables while low registration (above norm) and higher hypomania showed higher self-reported depression when compared to those with low registration (under norm) and those with normal registration. No significant differences were found concerning self-reported depression between the groups when referring to sensation seeking pattern as well. This is particularly significant when considering that the prevalence of low registration (above norm) was significantly higher among participants with hopelessness with a similar trend for those who are sensory sensitive and sensory avoiders, whereas no significance was reported when referring to sensory seeking.

According to the initial conceptualization of Petrie (1967) known as the reducer/augmenter theory, and subsequently Barnes (1976) who recalled this conceptualization as the stimulus intensity modulation theory, subjects respond differently to the same sensory stimulation according to different self-regulation strategies. An augmenter may be considered an individual subjectively amplifying/increasing incoming sensory stimulation whereas a reducer is generally a subject who dampens/reduces sensory stimuli. Given the same levels of sensory stimulation, the cortical responsiveness of reducers is slower/weaker when compared to that of augmenters (Buchsbaum and Pfefferbaum, 1971; Buchsbaum et al., 1983). Based on Larsen and Zarate (1990), reducers may be more prone to seek more intense stimuli to compensate their generally understimulated condition while augmenters may be more likely to avoid stimuli as they are commonly overstimulated. In order to obtain the same desired optimal level of internal subjective stimulation or arousal, reducers need more and augmenters less stimulation. Based on this perspective, if an individual is internally understimulated, an increased stimulation will be continuously searched but conversely, if the perceived stimulation is abnormally increased, a decreased stimulation will be searched. Larsen and Zarate (1990) reported that these personality characteristics are not determined by differences in the subjective perception of the optimal level of stimulation, but rather by differences in the amount of objective stimulation that is necessary to achieve/maintain this perceived level.

Table 4
Means and standard deviations of depression and hopelessness level, in patients with/without hypomania in the different SPD performance ranges.

	No hypomania		**Hypomania and sensory pattern under normal level**		**Hypomania and sensory pattern in normal level**		**Hypomania and sensory pattern above normal level**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Depression	20.48	12.51						
Sensory registration			17.08	10.43	21.38	9.64	29.86	12.57
Sensory seeking			23.13	11.64	23.76	12.94	23.01	12.88
Sensory sensitivity			16.95	11.61	21.43	10.97	28.57	11.68
Sensation avoidance			14.41	9.88	21.79	10.55	29.55	11.39
	No Hopelessness		**Hopelessness and sensory pattern under normal level**		**Hopelessness and sensory pattern in normal level**		**Hopelessness and sensory pattern above normal level**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Depression	13.63	9.92						
Sensory registration			20.41	9.53	25.21	9.66	32.73	10.98
Sensory seeking			26.36	11.11	30.76	10.35	31.25	15.73
Sensory sensitivity			20.18	7.39	24.32	10.86	31.86	10.25
Sensation avoidance			21.31	11.96	25.88	10.35	31.19	10.45

Note: #SD = standard deviation.

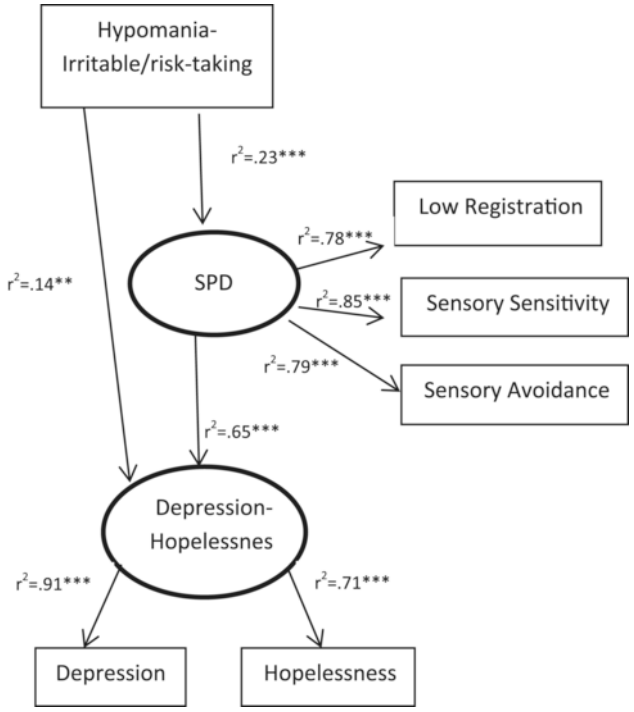

Fig. 1. Structural Equation Modeling to examine whether sensory profiles mediated the relation between hypomania, depression, and hopelessness.

Here, we speculate on the notion that the reducer may be identified as individuals with low registration of sensory input and sensory sensitivity whereas the augmenter mainly regards sensation seeking and sensory avoidance according to the Dunn's model. Based on our results and in line with our initial hypotheses, only lower registration and sensory sensitivity significantly correlated with elevated depression, hopelessness, and irritable/risk-taking hypomania.

This is also in accordance with another of our recent studies (Engel-Yeger et al., 2016a), in which we found that the hypo-sensitive pattern of low registration was associated with enhanced depressed mood and hopelessness while the hyposensitive pattern of sensory seeking may be considered as a resilient factor. Sensory seekers enjoyed physical and social interactions and were more likely to attend a resilience-promoting context around them similarly to hyperthymic subjects (Pompili et al., 2013; Rihmer et al., 2008). Now, the present study demonstrated that these individuals together with sensory avoiders are also more protected than low registrators and sensory sensitive subjects against developing irritable/risk-taking hypomania.

This revised conceptualization may be, in our opinion, of crucial importance for clinicians as differences among groups of patients exhibiting specific sensory patterns measured by the AASP are associated with relevant differences in their clinical background characteristics (e.g., self-reported depression, hypomania, and hopelessness), indicating that different sensory patterns are associated with different risk profiles and differential clinical outcomes. The early detection of individuals with low registration and sensory sensitivity (subjects who have been previously described by Petrie as "reducers") may help to rapidly target subjects who manifest higher depression, higher hopelessness but, more importantly, higher irritable/risk-taking hypomania levels at recruitment. Low registration and sensory sensitivity could serve to early identify in clinical practice specific at-risk subgroups of patients with enhanced vulnerability to negative outcomes and more aggressive psychiatric conditions.

4.2. Sensory profiles and their relation with self-reported depression, hopelessness, and hypomania

As low registration may contribute to the failure of detection of outer stimuli, lack of motivation, and difficulties in expressing emotions which are core factors contributing to higher hopelessness, this is in line with our results according to which the prevalence of low registration (above norm) was significantly higher among participants with BHS ≥ 9. Relevantly, the presence of hopelessness has been independently associated with higher suicide risk in clinical samples (Pompili et al., 2013; Rihmer et al., 2008).

Low registration and sensory sensitivity (the individuals who have been previously described by Petrie as "reducers") are also correlated with higher irritable/risk-taking symptoms which might play a major role in bipolarity and related psychopathological conditions rather than in unipolar conditions (Meyer et al., 2007; Holtmann et al., 2009). This is confirmed by our SEM analyses based on which there was a direct significant effect between irritable/risk-taking and depression-hopelessness. In particular, subjects with higher irritable/risk-taking were more likely to report greater sensory processing difficulties. Moreover, participants with greater sensory processing difficulties reported higher depression-hopelessness. The indirect effect from irritable/risk-taking hypomania on depression-hopelessness through sensory processing difficulties was significant with the mediation model explaining 48% of the variance of depression-hopelessness.

Similar results may be found in the current scientific literature. Brand et al. (2011) reported that subjects who presented irritable/risk-taking hypomania had more depressive symptoms, sleep disturbances, somatic complaints, perceived stress, and lower self-efficacy than those with active/elated hypomania or no hypomania. Benazzi and Akiskal (2005) also suggested that irritability during depressive episodes should be considered a valid marker of bipolarity although this clinical characteristic may be not sufficient to diagnose BD. The frequent difficulties involved in either retrospective and cross-sectional detection of hypomania, may at least partially explain the delayed diagnoses as well as the inadequate treatment approaches in the management of BD (Hirschfeld, 2014). There are negative potential consequences related to misdiagnosing bipolar patients who are experiencing a depressive episode as having unipolar depression (Hirschfeld, 2014). For instance, standard antidepressant treatment associated with a good evidence of efficacy in acute adult major depressive disorder (Girardi et al., 2009), has been demonstrated to be not effective in the treatment of depressive episodes in patients with BD, and treatment guidelines usually recommended using antidepressants only as an adjunctive therapy to mood stabilizers for bipolar depression (Yatham et al., 2013; Goodwin and Consensus Group of the British Association for Psychopharmacology, 2009).

Unfortunately, hypomania is not sufficiently investigated in clinical practice and patients not adequately managed as depressed bipolar subjects with the consequence of using inadequate treatments at abnormally higher dosages following the idea that they are unipolar depressed subjects (Perugi et al., 2011). This finding is also consistent with the assumption that during depression, "*dark*" symptomatology is usually more easily recognized as pathological rather than "*sunny*" symptomatology, often interpreted as 'normality' by the same patients (Perugi et al., 2011). Moreover, patients who suffer from a depressive episode are usually less likely to carefully recall episodes in which they were feeling cheerful or optimist.

During the last decades, the notion of affect/emotional dysregulation (the inability to regulate one's moods, feelings, and emotions) has received increased attention (Bradley, 2000). Individuals presumably manifest a growing ability regarding affect regulation ac-

cording to their maturation process, which allows them to cope with stressful life events seriously threatening their autonomy (Cheng and Boggett-Carsjens, 2005). Since affect regulation is a higher order value, it may be hypothesized that affect dysregulation may be related to the emergence of earlier developmental deficits such as sensory processing problems (De Gangi et al., 2005).

4.3. Study strengths and limitations

There are certain limitations that need to be considered in the interpretation of the present results. First, as we exclusively recruited outpatients of a single psychiatric unit, this sample do not represent patients with major affective disorders in general in terms of socio-demographic and clinical characteristics. Second, the cross-sectional nature of this study do not allow the generalization of the main findings. Although SEM analyses were used to examine whether sensory profiles are a significant mediator between hypomania and depression/hopelessness, these results should be considered preliminary and need to be replicated. Third, we used only self-report measures in our study that may be potentially biased by social desirability. For instance, the current mood state of participants could have yielded a recall bias on their previous hypomanic state as assessed using the HCL-32. Finally, the possible confounding effect of psychoactive medications (e.g., antidepressants, mood-stabilizers, benzodiazepines) which have been administered to our participants has been not taken into account.

Although the mentioned limitations, the present study is meaningful as it represents, to the best of our knowledge, the first study to evaluate the association between sensory processing patterns, hypomania, self-reported depression, and hopelessness in a clinical sample. Future studies are required to further explore the complex association between sensory reactivity and vulnerability or resilience in major affective disorders and illuminate their impact on individuals' ability to function in the *real world*.

4.4. Conclusion

Extreme sensory processing patterns may potentially play a fundamental role in the pathophysiology of subjects with major affective disorders and regulation problems. In particular, low registration was associated with enhanced depressed mood and hopelessness while sensory seeking may be considered as a resilient factor in euthymic unipolar and bipolar patients. Sensory processing problems seem to recur in numerous psychiatric conditions, and there is uncertainty about whether it constitutes a distinct disorder or not. Overall, there is the serious need for further research showing the validity of the sensory processing disorders concept as well as its clinical utility in major affective conditions. Clinicians may wish to consider the presence of sensory processing difficulties as an early indicator of prognostic trajectory.

Uncited references

(Hazewinkel, 2001; Serafini et al., 2016a, 2016b).

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