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ORIGINAL ARTICLE

Not Just Right Experiences, Disgust Proneness and Their Associations to Obsessive–Compulsive Symptoms: A Stringent Test with Structural Equation Modeling Analysis

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Abstract

Although "not just right experiences" (NJREs) and disgust proneness (DP) have been increasingly implicated in the development and maintenance of obsessive–compulsive disorder (OCD), no studies to date have examined their conjoint effect. In the present study, structural equation modeling was used to examine the extent to which NJREs and DP were associated to OC symptoms in a sample composed of college students in a model which also included OC-related beliefs and negative affect. The results showed that NJREs and OC-beliefs, but not DP, were related to overall OC symptoms severity. Moreover, NJREs were associated to all the main OC symptoms dimensions (washing, checking, ordering, obsessing, and mental neutralization) whereas DP was associated with obsessing symptoms and, negatively, with mental neutralization. These findings underscore the importance of the continued examination of vulnerability factors such as NJREs and DP in enhancing our understanding of OCD.

Keywords Not just right experiences · Disgust proneness · Beliefs · Structural equation modeling · Obsessive–compulsive symptoms

Obsessive–compulsive disorder (OCD) is a serious mental condition characterized by obsessions and/or compulsions that are distressing, time consuming, or significantly impairing (Kugler et al. 2013). Although OCD represents one of the most incapacitating psychiatric disorders, much remains

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unknown about its etiopathogenetic components (e.g., Olatunji et al. 2017; Sica et al. 2010).

Given the heterogeneity of obsessive–compulsive (OC) symptoms, etiologic heterogeneity is likely to be the best fitting model (e.g., Abramowitz and Jacoby 2015). As such, it is not surprising that many OC related constructs have been identified by psychological research. Among them, the so-called "Not Just Right Experiences", the disgust proneness and a few OC-related beliefs have been increasingly indicated as putative motivational processes underlying OCD (e.g., Obsessive Compulsive Cognitions Working Group [OCCWG] 1997; Olatunji et al. 2017; Sica et al. 2016).

Not Just Right Experiences

Not Just Right Experiences (NJREs) are defined as the subjective impression that "something is not just right" (Sica et al. 2015; Summerfeldt et al. 2014), also labeled as sensations of "incompleteness", that is the sense that actions, intentions and perceptions have been incompletely achieved. An increasing number of studies have confirmed the role of NJREs in OCD (e.g., Belloch et al. 2016; Bottesi et al. 2017; Coles et al. 2003; Cougle et al. 2013; Ghisi et al. 2010; Hellriegel et al. 2016; Summerfeldt et al. 2014). For example, significant associations have been found between NJREs and OCD or OC symptoms in nonclinical and clinical populations both in cross-sectional and longitudinal studies (e.g., Belloch et al. 2016; Ghisi et al. 2010; Sica et al. 2012; Taylor et al. 2014).

In addition, several studies have demonstrated that NJREs elicited in the laboratory predicts OC symptoms (e.g., Belloch et al. 2016; Cougle et al. 2013). In a recent study Fornés-Romero and Belloch (2017) induced NJREs in a clinical OCD sample and nonclinical individuals by disrupting the performance during a free recall task. In the OCD sample, NJREs correlated with compulsions severity and were associated with ordering, washing, and hoarding symptoms. Among nonclinical participants, NJREs were the main contributors to urges and impulses to repeatedly do something during task performance, thus supporting the role of NJREs as compulsions motivator.

Moreover, available evidence suggests that NJREs could be somewhat *specific* to OCD (e.g., Coles et al. 2005; Ghisi et al. 2010; Sica et al. 2015; Taylor et al. 2014). Interestingly, clinical reports also confirmed the importance of NJREs in OCD. For instance, Coles et al. (2012) found that increases in the strength of urges for things to feel 'just right' were commonly indicated by patients as a factor contributing to the onset of OCD (see also, Van Schalkwyk et al. 2016).

Disgust Proneness

Disgust proneness (DP), a stable personality trait that is present to a greater or lesser extent in all individuals (Olatunji and Broman-Fulks 2007), has also been implicated in OCD. Given that disgust is thought to serve a disease-avoidance function (Matchett and Davey 1991), it has been posited that contamination-based OCD represents a dysfunction in DP (Husted et al. 2006). DP might be related to contamination-based OCD by motivating individuals to overestimate the association between disgust-relevant stimuli and disease outcomes. Consistent with this view, research has shown that individual differences in DP predict the subjective likelihood of catching a disease when confronted with potentially contaminated stimuli, even after controlling for anxiety symptoms (Mitte 2008). In fact, neuroimaging research has shown that the neural substrates involved in DP may be relevant to the contamination/washing symptom dimension of OCD as well (Husted et al. 2006).

Although a stronger association between DP and OC symptoms is commonly observed with the contamination subtype, a few studies have also found significant associations between this construct and other types of OC symptoms (Melli et al. 2015; Olatunji et al. 2010). Olatunji et al. (2011) also found that changes in DP predicted changes in overall OCD symptoms across 2–3 weeks of intensive OCD treatment.

OC-Related Beliefs

Cognitive-Behavioral models propose that OC symptoms are motivated by specific dysfunctional beliefs (e.g., beliefs that threat is ever-present, beliefs that uncertainty is intolerable, beliefs that unwanted intrusive thoughts are dangerous, and beliefs that one is personally responsible for anticipating and preventing harm). Thus, dysfunctional obsessive beliefs or schemas are conceptualized as risk factors for the development of OC symptoms or behavioral, cognitive, and emotional features that are indicative of the disorder. Consistent with this risk model, cross-sectional studies showed that such beliefs are correlated with OC symptoms (e.g., OCCWG 2005), whereas prospective investigations have shown that the beliefs predict the onset or worsening of OC symptoms (e.g., Abramowitz et al. 2006). Also, treatment studies have shown that the beliefs decline over the course of successful cognitive-behavioral therapy for OCD (e.g., Whittal et al. 2005). Lastly, research has shown that first-degree relatives of OCD probands often exhibit obsessive beliefs that place them at risk for OCD (Rector et al. 2009).

Since the role of OC-beliefs towards OC symptoms is rather established (for a review, see Mckay et al. 2004), we

deemed important to examine the extent to which NJREs and DP were associated to OC symptoms over and above this construct.

The Current Study

Since OC symptoms are not explained by a single theoretical model, we believe that a systematic investigation of relevant psychological constructs, such as NJREs and DP could further clarify this complex and still obscure disorder. Unfortunately, these constructs have largely been examined in isolation, so there are no evidences about their role in explaining OC symptoms when investigated in combination. In fact, NJREs and DP could share a sensory-affective quality: both entail unpleasant (and sometimes intolerable) sensations which drive the individual to do something to get rid of them. Interestingly, according the basic psychological search, disgust is a "sense-based" emotion (McGinn 2011); likewise, NJREs refers to "an inner sense of imperfection" (e.g., Pitman 1987). Moreover, according the cost and benefit hypothesis (Carretié et al. 2011), DP evolutionarily elicits stronger uncertainty (i.e., NJREs) compared to fear, owing to the ambiguous nature of the stimuli. For instance, in a visual search task to measure differential attentional biases elicited by neutral, disgust-, and fear-specific pictorial material, participants were significantly more *confident* in answering questions referring to fear compared to disgust pictures (Fink et al. 2018).

In summary, there are several conceptual reasons which suggest that NJREs and DP could be related to OC symptoms through some common mechanisms, but no attempts have been carried out to explore this possibility. Such issue can be empirically investigated by considering the extent to which NJREs and DP are associated to OC symptoms in the same model. Accordingly, the present investigation employs structural equation modeling (SEM) to examine the role of NJREs and DP in the associations to OC symptoms, in a sample of college students. Building on previous work suggesting that these factors may represent distinct putative vulnerability factors that cut across overt symptoms in OCD (Olatunji et al. 2011; Sica et al. 2016), it was hypothesized that they would independently relate to OC symptoms in general. Moreover, since a few studies found a preferential link between NJREs and ordering/symmetry (e.g., Fornés-Romero and Belloch 2017; Taylor et al. 2014) we speculated that NJREs should be related to ordering symptoms at a larger extent than DP. Likewise, given the disease-avoidance function of disgust, it was also predicted that DP would be especially associated with symptoms of contamination.

Since a large body of research has conceptualized OC-related beliefs as a risk factor for the development of OC symptoms, it is important to examine the extent to which the vulnerability factors identified are associated to OC symptoms above and beyond this construct. In particular, NJREs could be simply an alternative indicator either of the belief that "uncertainty is intolerable" or that "doing something perfectly is possible and necessary" (*Perfectionism/certainty*). Likewise, DP could be strongly linked to an exaggeration of the probability or severity of harm, such as "I believe that the world is a dangerous place" (*Threat estimation*). Therefore, it is important to rule out that NJREs and DP relate to OC symptoms mainly because of presence of the cognitive component (OC-beliefs) identified in the cognitive behavioral model of OCD.

Lastly, we wanted to ascertain the relation between NJREs, DP and OC symptoms taking into account the role of negative affect which has been identified as possible higher order generalized vulnerability factor for psychopathology (Olatunji et al. 2011; Taylor et al. 2014).

Therefore, through this research design we conducted a stringent test of the specificity of associations between NJREs, DP and OC symptoms.

We examined our hypotheses using a nonclinical sample because: (a) OC symptoms are common in the general population, (b) clinical and nonclinical samples share common features such as the form and content of OC symptoms, (c) taxometric research suggests that clinical and nonclinical OC symptoms are continuous with one another (i.e., clinical symptoms are simply a more severe version of nonclinical symptoms), and (d) behavioral-genetic (twin) research indicates that clinical and nonclinical samples yield the same pattern of results concerning the genetic and environmental etiology of OC symptoms (for a review see Abramowitz et al. 2014).

Method

Participants and Procedure

Undergraduates enrolled in Italy (University of Florence; N = 295, 51% females), Spain (University of Valencia N = 204; 51% females), and USA (Vanderbilt University, Tennessee; N = 269; 57% females) participated in the current study. In each site, at least the 90% of students agreed to participate; this figure is similar to rates in our previous studies with other college-recruited samples (e.g., Arrindell et al. 2013). In all sites participants completed the measures online; in USA only, participants obtained a research credit in exchange. All participants were informed of the study's aims and gave their informed consent before entering the study. The research was conducted in accordance with the Declaration of Helsinki and ethical approval was obtained from the institutional ethics committee in each Country involved in the study.

Measures

Not Just Right Experiences-Questionnaire-Revised

(NJRE-Q-R; Coles et al. 2005). It includes 19 items. This measure yields two overall indices: the *NJRE-Q-R-total* (i.e. the number of actual NJREs experienced; range 0–10) and the *NJRE-Q-R severity scale* (i.e. the severity related to the most recent NJREs (see, for instance Sica et al. 2015; Taylor et al. 2014). The Italian version of the NJRE-Q-R demonstrated good psychometric properties in several studies (e.g., Ghisi et al. 2010; Sica et al. 2012, 2013, 2015). The Spanish version of the NJRE-Q-R was validated with 253 non-clinical participants (Belloch et al. 2016; Carrasco and Belloch 2013). The Spanish NJRE-Q-R correlated at a moderate level with all the Obsessive–Compulsive Inventory-Revised (OCI-R) dimensions; moreover, associations with the OCI-R total score remained significant after controlling for anxiety and depression. In the current study Cronbach's alpha for the entire sample was .65 for NJRE-Q-R-total and .90 for the NJRE-Q-R severity scale.

Disgust Propensity and Sensitivity Scale-Revised

(DPSS-R; van Overveld et al. 2006). It is a 16-item measure designed to assess the frequency of disgust experiences (*Disgust Propensity*) and the emotional impact of disgust experiences (*Disgust Sensitivity*). A total score is obtained by summing up the propensity and sensitivity score. Subjects rate their agreement with each item on a scale ranging from 1 (''never'') to 5 (''always''). The Italian, Spanish, and US version of the DPSS-R demonstrated good reliability, convergent validity (e.g., positive correlations with anxiety disorder symptoms and negative affect), and discriminant validity (e.g., negligible relation to positive affect; Martoni et al. 2017; Olatunji et al. 2007a; Sandin et al. 2008). In the current study Cronbach's alpha for the entire sample was .89 for Disgust Propensity scale and .83 for Disgust Sensitivity scale.

Obsessive–Compulsive Inventory-Revised

(OCI-R; Foa et al. 2002). It is a widely used 18-item self-report questionnaire assessing the severity of OC symptoms on 5-point Likert scale. Items are grouped into six subscales *(washing, checking, ordering, obsessing, hoarding, and mental neutralizing*). Initial reports supported the reliability and validity of this instrument, and showed strong convergence with established measures of OCD, moderate to high internal consistency across the six subscales, and adequate to high test–retest stability (Foa et al. 2002). The Italian and the Spanish version of OCI-R indicated good internal consistency and test–retest reliability, as well as good convergent, divergent, and criterion validity (Belloch et al. 2013; Sica et al. 2009). In the current study, the hoarding subscale was excluded as hoarding symptoms appear to represent a separate type of mental health problem (e.g., Pertusa et al. 2010). In the current study alpha reliabilities for the entire sample ranged from .61 of Mental Neutralizing scale to .88 of the OCI-R Total score.

Obsessive Beliefs Questionnaire-44

(OBQ-44; OCCWG 2005). It is a self-report instrument consisting of 44 items representing dysfunctional beliefs assessed in 3 domains identified by the OCCWG as central to OCD: *Responsibility/Threat Estimation, Perfectionism/Certainty, and Importance/Control of thoughts.* A total score is also computed by summing the scores for each domain. The OBQ-44 is a widely-used measure of OC cognitive domains and has shown good internal consistency as well as good validity also in Italy and Spain (Dorz et al. 2009; Ruiz et al. 2008; see also Sica et al. 2006). In the current study alpha reliabilities for the entire sample were .90 or higher for the three OBQ-44 subscales.

Positive and Negative Affect Schedule

(PANAS; Watson et al. 1988). It is conceptualized as a trait measure of general mood/affect. It consists of 20 adjective descriptors of various positive and negative affective states, broken down into two 10-item subscales: Positive Affect and Negative Affect. Individuals indicate how much each mood descriptor applies to them using a 5-point Likert scale anchored by ''very slightly or not at all'' to ''extremely''. The PANAS scales show excellent psychometric properties (reliability, convergent and divergent validity) and they have been translated into several languages. The Italian version of the PANAS was validated on a combined (undergraduates and community individuals) sample of 600 non-clinical participants (Terracciano et al. 2003). Its factor structure resembled that of the original version, and it showed excellent internal consistency values as well as excellent concurrent validity. The Spanish version of the PANAS was validated on a sample of 712 undergraduates (Sandin et al. 1999). Results revealed a robust and stable two-dimensional structure and provided strong support to construct validity and reliability. In the current study only the Negative Affect scale was used and its alpha value for the entire sample was .88.

Statistical Analyses

Overall, less than 5% of answers were missing. Based on missing data procedures recommended by Graham (2009), maximum likelihood estimates of the missing data (EM algorithms) were then computed and used for subsequent

analyses (Little and Rubin 2002). Pearson correlations were used to examine the association among the measures under scrutiny. Following Cohen's (1988) classification, large correlations were defined as 0.50 and above, medium correlations between 0.30 and 0.49, and small correlations between 0.10 and 0.29.

All the above analyses were conducted using IBM SPSS statistics, version 22.

Structural Equation Modeling

There were five factors in this model: (1) OC symptoms severity (identified by the OCI-R subscales); (2) NJREs (identified by the two NJRE-Q-R scores); (3) DP (identified by the two DPSS-R scale scores: disgust propensity and disgust sensitivity); (4) OC-related beliefs (identified by the three scales of the OBQ-44); [1] (5) Negative Affect (identified by the 10 items of the PANAS negative affect scale). [2] Five other models were tested with each subscale of the OCI-R (identified by its three items) as a measure of severity of specific symptoms (i.e., washing, checking, etc.), whereas all the other factors remained the same as in the first model.

To determine the fit of the CFA models, we considered the χ^2 test statistic, the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Unfortunately, the χ^2 test statistic is strongly affected by the sample size; therefore, CFI and TLI values larger than 0.90 are taken to indicate acceptable fit, although values greater than .95 are desirable (Hox et al. 2010). Likewise, RMSEA values lower than .05 indicate close fit, values between .05 and .08 indicate acceptable fit, values between .08 and .10 indicate mediocre fit, and values greater than .10 indicate poor fit (Browne and Cudeck 1992). Lastly, SRMR values range from 0 to 1.0, with well-fitting models obtaining values smaller than .05 (Byrne, 1998); however, values as high as .08 are deemed acceptable (Hu and Bentler 1999). For these analyses, we used the SEM approach as implemented in the LAVAAN package for the R statistical computing environment (version 3.3.2).

[1] Indeed, a recent research showed that the general obsessive beliefs factor identified by the three scales of the OBQ-44 robustly predicted the latent OCD spectrum factor above and beyond the three distinct obsessive belief dimensions (Olatunji et al. 2019). The authors concluded that the OBQ-44 total score may be more useful in predicting OCD than the subscale scores.

[2] The test of the multigroup invariance of this five-factor model exhibited an acceptable fit both for configural as well as metric invariance (See Online Resources).

Results

Preliminary Analyses

The sample was balanced for gender (53% females), with a mean age typical of undergraduate students (about 23 years old). Means, standard deviations and reliabilities for all measures are reported in Table 1 in the Online Resources.

In Table 1 the zero-order correlations among the study measures are displayed. The correlation values between DP propensity and sensitivity and the OCI-R Total score were .35 and .40, respectively; the values between NJREs severity, total score and OCI-R Total score were, respectively, .51 and .53; the values between OC-related cognitions (as measured by the three OBQ-44 scales) and OCI-R Total ranged from .47 to .54.

Regarding specific OC symptoms, the two indices of DP as well NJREs exhibited the largest correlation with the obsessing subscale of the OCI-R (*r*s from .34 to .44) and the smallest one with the neutralization subscale (*r*s from .06 to .24). As expected, the association between the OBQ-44 Total and the OCI-R subscales were roughly similar each other and of medium size. Lastly, the total score of DP was associated to the two NJREs indices and to the OBQ-44 Total at a medium degree of magnitude; also, the correlations between the two NJREs indices and the OBQ-44 Total were of medium size.

Measurement Models

The fit of the five-factor measurement model with the five OCI-R subscales (OCI-R factor) was good (i.e., χ^2/DF ratio = 4.9; CFI = .99, TLI = .98, RMSEA = .07; SRMR = .05; see Fig. 1 in the Online Resources). Also, the five-factor measurement models with each of the OCI-R subscales showed good values of fit (Table 2 in the Online Resources).

Structural Equation Modeling with OC Symptoms

NJREs, as well as OC-related cognitions, were significantly correlated with the OC symptoms severity factor ($\zeta = .45$, $z = 7.8$, $p < .01$; $\zeta = .38$, $z = 8.4$, $p < .01$ respectively; see Fig. 1). In addition, the path from NJREs to OC symptoms factor was significantly greater than the path for the OC-related cognitions counterpart ($\chi^2_{(1)} = 7.2$ p = .007). The path from the DP factor to the OC symptoms severity factor was marginally significant ($\zeta = .07$, $z = 1.8$, $p = .06$).

The NJREs factor was also associated to each of the OCI-R subscales, whereas the DP factor was related to the obsessing subscale of the OCI-R and, in opposite way (i.e., negatively), to the mental neutralization symptoms (Table 2;

Table 1 Correlations among NJREs, disgust propensity, OC cognitions, positive/negative affect and OC symptomatology for the sample

	2	3	4	5	6	7	8	9	11	12	13	14	15	16	17
1. DPSS-R propensity	.77	.94	.42	.27	.30	.26	.16	.28	.49	**.24**	**.21**	**.28**	**.34**	**.06**	**.35**
2. DPSS-R sensitivity		.94	.40	.27	.35	.28	.23	.33	.49	**.23**	**.25**	**.27**	**.43**	**.12**	**.40**
3. DPSS-R total			.43	.29	.35	.29	.21	.33	.52	**.25**	**.25**	**.30**	**.41**	**.10**	**.40**
4. NJRE-Q-R severity				.55	.41	.44	.33	.46	.19	**.29**	**.34**	**.39**	**.44**	**.24**	**.51**
5. NJRE-Q-R total					.44	.43	.35	.47	.06	**.36**	**.37**	**.37**	**.40**	**.28**	**.53**
6. OBQ44 resp/threat						.72	.67	.91	.10	**.35**	**.35**	**.39**	**.47**	**.26**	**.54**
7. OBQ44 perf/certainty							.58	.90	.08	**.30**	**.36**	**.45**	**.40**	**.26**	**.53**
8. OBQ44 imp/control								.81	.00	**.33**	**.26**	**.30**	**.45**	**.27**	**.47**
9. OBQ-44 total									.08	**.37**	**.37**	**.44**	**.50**	**.30**	**.59**
11. PANAS negative										.01	.02	.01	.13	.04	.05
12. OCI-R washing											.38	.41	.35	.36	.66
13. OCI-R checking												.46	.35	.37	.72
14. OCI-R ordering													.26	.33	.73
15. OCI-R obsessing														.36	.67
16. OCI-R mental neutralizing															.60
17. OCI-R total															

In bold correlations between OC-related constructs and OC Symptoms. All correlations greater than .12 are significant at a $p < .01$

DPSS-R disgust propensity and sensitivity scale-revised, *NJRE-Q-R* not just right experiences questionnaire revised, *OBQ-44* obsessive beliefs questionnaire-44 items, *PANAS* positive and negative affect schedule, *OCI-R* obsessive–compulsive inventory-revised

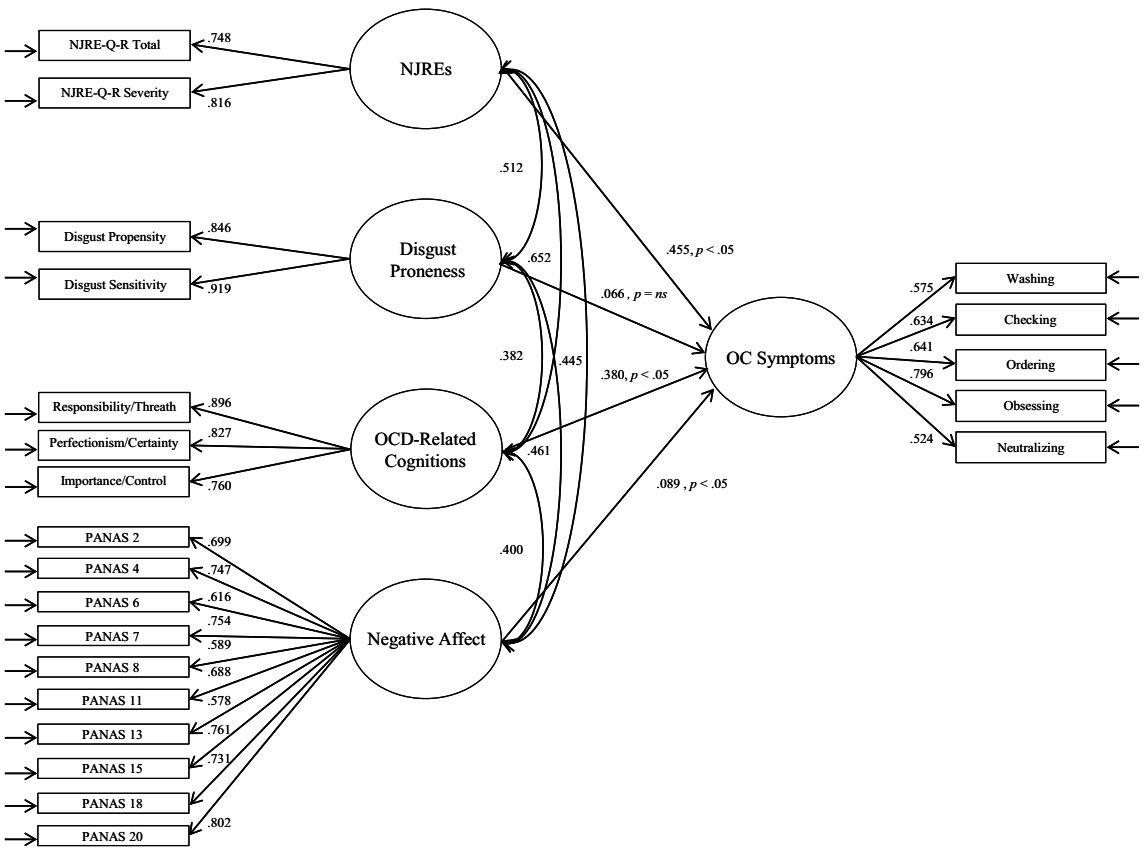

Fig. 1 Path diagram representing the SEM relating the exogeneous variables NJREs, DP, OC-related cognitions and negative affect to the endogenous variable representing OC symptom severity. Straight arrows represent causal effects whereas curved arrows represent mere associations (correlations). *PANAS* positive and negative affect schedule

Table 2 Path values of the SEM models with the NJREs, DP, PANAS, and OBQ factors as latent variables and each subscales of OCI-R as a dependent variable

	NJREs	DP (DPSS-R)	PANAS—negative	OBQ—44 total
OCI-R washing	.37*	.06	.01	.23*
OCI-R checking	.47*	.01	.14*	.04
OCI-R obsessing	.37*	.13*	.29*	.13*
OCI-R ordering	.43*	.03	.08	.17*
OCI-R neutralizing	.35*	−.16*	.19*	.11

DPSS-R disgust propensity and sensitivity scale-revised, *NJRE-Q-R* not just right experiences questionnaire revised severity and total score, *OBQ-44* obsessive beliefs questionnaire-44 items, *PANAS* positive and negative affect schedule, *OCI-R* obsessive–compulsive inventory-revised

*p < .05

see also Figs. 2 to 6 in Online Resources). In both cases, the paths from NJREs to both obsessing and mental neutralization symptoms were significantly greater than the paths for the DP factor counterpart (respectively, $\chi^2_{(1)} = 7.5$ p = .006 and $\chi^2_{(1)} = 15$ p < .001).

For sake of comparison, the OC-related cognitions were associated to the OCI-R washing, obsessing and ordering subscales (Table 2). The path from the NJREs to the OCI-R washing subscale was not different from the path for the OBQ-44 counterpart ($\chi^2_{(1)} = 0.8$ p = .38), whereas the paths to the OCI-R obsessing and ordering subscales were greater than the path for the OBQ-44 counterparts ($\chi^2_{(1)} = 7.5$ p = .006; $\chi^2_{(1)} = 5.8$; p = .02 respectively). Lastly, the path from the OBQ-44 to the OCI-R obsessing subscale was not different from the path for the DP counterpart $\chi^2_{(1)} = .01$ p = .90; Figs. 2 to 6 in Online Resources).

Discussion

The present study used a SEM approach to examine the effects of NJREs and DP on OC symptoms in a large sample of undergraduates, when controlling for OC-related beliefs and negative affectivity, that is under stringent methodological conditions. The main findings are as follows: (1) NJREs and, barely, DP were associated to the OC symptoms severity factor; (2) NJREs also correlated with all OC symptoms dimensions (i.e., washing, checking, ordering, obsessing, and mental neutralizing), whereas DP was positively associated to obsessing symptoms and negatively associated to mental neutralization.

The present findings suggest that NJREs are especially robust towards OC symptomatology; noteworthy, this effect was obtained after controlling for others well-known vulnerability factors as well as negative affect. Moreover, NJREs appear to play a role also for symptoms different from symmetry/ordering. Overall, this result is consistent with those of previous research. For example, Sica et al. (2013) found that parental NJREs predicted OC symptoms in their offspring; Taylor et al. (2014) also found that NJREs significantly predicted OC symptoms even after controlling for harm avoidance in nonclinical samples (see also, Hellriegel et al. 2016).

NJREs may partially reflect the "sensory-affective" regulation dysfunction that several scholars consider pivotal for explaining, at least in part, OCD psychopathology (i.e., McGovern and Sheth 2017; Riesel et al. 2015). Given that much of the available research has been correlational, experimental approaches that allow for the manipulation of NJREs may provide more definitive causal inference. For example, Fornés-Romero and Belloch (2017) found that compulsion severity correlated with the need to do something and to check after experimental induction of NJREs in patients with OCD.

Contrary to predictions, the DP factor was not significantly related to the washing symptoms in a model that also included NJREs, OC-related beliefs and negative affect as latent variables. Unfortunately, since these three putative vulnerability factors have been examined disjointedly so far, there is no a firm theoretical ground to explain such result. From a phenomenological point of view, however, it is possible to speculate that NJREs and DP may both capture a sense of an altered "sensation" but at a different level of specificity. Indeed, NJREs are currently considered rather specific to OC symptoms (Sica et al. 2015), whereas interoceptive intolerance of disgust experiences can represent an index of broader emotion regulation deficits (Rozin et al. 2008). As such, the association between DP and OC symptoms may be stronger when the covariate is a generalized risk factor (i.e., negative affect; Olatunji et al. 2011) versus a lower-order risk factor that may have more specificity, such as NJREs and OC-related beliefs. Such account may also explain why the DP factor was barely significant in predicting the OC symptoms as a whole.

Interestingly, a study on the feelings of internal dirtiness that occur in the absence of a physical contaminant (the so-called "mental contamination", a phenomenon akin to NJREs) showed that such feelings cross-sectionally mediate the relationship between disgust propensity and contamination fears, suggesting that *sensations* of dirtiness may be a mechanism by which disgust propensity contributes to contamination fears (Melli et al. 2014). Moreover, Mathes et al. (2019) examined the role of NJREs as well as disgust propensity in contamination symptoms in a study on

behavioral treatment of contaminations-based OCD. They found that reactivity to the NJREs task remained a significant predictor of follow-up contamination symptoms even when accounting for disgust propensity. They concluded that it may be that washing compulsions are intended in part to reduce feelings that things are "not just right".

The lack of predictive power of DP towards washing symptoms may be also explained by the heterogeneity of such symptoms (e.g., Feinstein et al. 2003; Garcia-Soriano et al. 2016): that is, not all washing symptoms may be motivated by disgust and in fact the OCI-R washing subscale is composed of three items only.

The evolutionarily adaptive role of disgust for avoiding contact contamination may explain why *higher* DP scores predicted *less* mental neutralization. That is, a greater tendency to experience disgust is likely to lead to a stronger sense of internal distress, which in turn increases avoidance of potential contaminants, as well as a need for the individual to cleanse themselves after contact with subjectively contaminated objects (see also, Cisler et al. 2009; Olatunji et al. 2007b). Such reaction is at odds with counting and repeating numbers (the content of the OCI-R mental neutralization subscale) to deal with the distress; therefore, high levels of disgust would prompt the individual to perform some action to get rid of such unpleasant emotion instead of trying to search for relief through a mental activity involving counting numbers.

Lastly, even though not hypothesized, the association between obsessing symptoms and disgust was not entirely unexpected. First, in a few studies DP significantly predicted religious obsessions even after controlling for general fearfulness and cleanliness fears (e.g., Inozu et al. 2017). In addition, Olatunji et al. (2016) employed structural equation modeling to examine the association between DP (identified by the DPSS-R) and a contamination-based OC factor and a noncontamination-based OC factor in 296 undergraduates. Results showed that the path from DP to contamination-based OC was significantly *weaker* than the path from DP to non-contamination OC.

Consistent with our hypotheses, the results of the SEM described above suggest an important role of NJREs, but one may say that NJREs could be related to OC symptomatology stronger than DP (and dysfunctional beliefs) because they are themselves OC symptoms (e.g., Fergus 2014). For space reason we can only summarize here why this is not the case, but the reader can consult an extended discussion about this topic elsewhere (e.g., Sica et al. 2015). First, many NJRE-Q-R items do not overlap with those measured by the OCI-R; in fact, the NJRE-Q-R is focused on *sensations* and not with thoughts, images or impulses typical of OCD. Second, in all studies where the NJRE-Q-R severity score has been used, the correlation between this measure and the OC symptoms was in the moderate range, both in clinical and nonclinical samples. Third, in an experimental task evoking NJREs (e.g., disharmonic chord sequences) a measure of NJREs but not the OCI-R total score was correlated to a faster response to such deviant auditory perceptions (Buse et al. 2014). Lastly, in an experimental study we probed cognitive flexibility by using symptom-related stimuli in a probabilistic reversal learning task. We compared performance of individuals with either OC symptoms or NJREs. The results showed that inflexibility was typical of individuals with OC symptoms but not of individuals characterized by NJREs (Caudek et al. submitted).

The present study, in conjunction with previous research, strengthens the view of OCD as a complex disorder where the sensory and affective features are at least as important as other long-established mechanisms (e.g., OC-related beliefs) associated to such serious psychopathology. Therefore, from a clinical point of view it may be beneficial to encourage patients to reappraisal/tolerate NJREs (see for instance, Mason and Richardson 2012; Summerfeldt et al. 2014). Relatedly, it may be useful to conduct exposures to the discomfort and tension related to NJREs and disgust (see also, Coles and Ravid 2016). Lastly, encouragement to tolerate the doubts associated with unwanted thoughts such as sex, harm/violence, and religion/blasphemy (e.g., through some modified mindfulness practice) may provide some relief to the often exhausted and helpless individuals. This would be important, provided that approximately 25% of OCD patients report distressing obsessions without overt compulsive rituals (e.g., Sica et al. 2010).

Limitations

Although the present study highlights the differential effects of NJREs and DP on OC symptoms under stringent conditions, the limitations of the study must be considered before definitive inferences can be made. First, participants consisted of a somewhat homogenous sample of undergraduates; for this reason, follow-up research is needed to evaluate the generalizability of findings to clinical samples even though the dimensionality of OC symptoms suggests that studies with nonclinical samples can offer data that can inform thinking about OCD (see Abramowitz et al. 2014). Another limitation is that the measures of DP and OC symptoms examined in the present study are by no means exhaustive. Future studies might consider other measures of NJREs, DP, and OC symptoms to further examine the measurement parameters of the present findings. It is likewise important to note that the present study is limited by the exclusive reliance on self-report measures. Consequently, the relationships among our factors may be inflated because of questionnaire-specific method variance. Future research employing indicators from other assessment modalities will

allow for more definitive inferences to be made. For instance, our group is now developing a picture-rating method for assessing NJREs which allows a more "direct" evaluation of uncomfortable sensations (Sica et al. submitted). The cross-sectional nature of the present study is also a limitation that does not allow for causal inferences. Longitudinal research along these lines will prove valuable in further clarifying the extent to which NJREs and DP function synergistically and or interactively to cause the development of OCD.

Conclusions

In sum, this study suggests that it is important the exam of affect-specific vulnerabilities to enhance our understanding of complex and still obscure phenomena such as OCD.

Compliance with Ethical Standards

Conflict of interest Claudio Sica, Corrado Caudek, Amparo Belloch, Gioia Bottesi, Marta Ghisi, GabrieleMelli, Gemma García-Soriano, Bunmi O. Olatunji, declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent All participants were informed of the study's aims and gave their informed consent before entering the study.

Animal Rights This article does not contain any studies with animals performed by any of the authors.

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