

Investigating the role of anticipatory reward and habit strength in obsessive-compulsive disorder

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Aims. To determine the rates and associated illness characteristics of obsessive-compulsive disorder (OCD) patients who describe their symptoms as either rewarding or habitual.

Methods. Seventy-three treatment-seeking OCD patients had their dominant compulsive behavior assessed with a structured interview (the Temporal Impulsive-Compulsive Scale-Revised) to track the progression of rewarding (ie, gain in positive affect), aversive (ie, decrease in negative affect), and neutral (or non-affective) states and a self-report scale (the Self-Report Habit Index) to evaluate their habitual features. Additional measures included structured diagnostic interviews for axis I and II disorders, measures of OCD symptoms severity, and a battery of instruments to comprehensively assess relevant aspects of sensitivity to reward and fear.

Results. Almost half (49%) of our OCD patients (particularly washers) endorsed that they anticipated obtaining a reward (ie, positive affect) from the enactment of their dominant compulsive behavior. Washers stood out in that their positive affects *during* and *after* compulsive behaviors were highly (and positively) correlated with duration of illness. In contrast, habit strength did not differ between washers, checkers, and arrangers, although it also correlated with duration of illness among checkers. Furthermore, the severity of OCD and comorbidity with impulse control disorders predicted up to 35% of the variance in the habit strength of OCD behaviors.

Conclusion. Compulsive washing may be more clearly characterized by problems in reward processing. In contrast, duration of checking, severity of OCD, and comorbidity with impulse control disorders shape compulsive behaviors by imparting them with habitual tendencies.

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Introduction

Emerging evidence suggests that the boundaries between compulsive symptoms in obsessive-compulsive disorder (OCD) and both addictive and habitual behaviors may not be impervious as previously thought. For instance, OCD and impulse control disorders (ICDs), including conditions conceptualized as substance and behavioral addictions and grooming/habit disorders, frequently co-exist in the same patient.¹ Accordingly, some OCD patients also report very little, if any, resistance to, and

control over, their compulsive behaviors²—a phenomenon well known in both the psychoanalytic³ and behaviorist literature.⁴ In experimental laboratory conditions, OCD patients exhibit an increased tendency to form both avoidance and “rewarding” habits.^{5–7} One recent functional MRI (fMRI) study found OCD patients, particularly the washing subtype, to exhibit attenuated activity in the nucleus accumbens, a key region of the brain reward system,⁸ during gain anticipation compared to healthy controls.⁹ Furthermore, the nucleus accumbens is a core therapeutic target for deep brain stimulation, which has been shown to be effective in the management of treatment-refractory OCD.¹⁰

In a preliminary study of how affect and behavior dynamically interact to influence OCD behavior, we

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showed that most OCD patients reported an increase of positive affect, as measured by the Positive and Negative Affective Schedule (PANAS) in anticipation of the performance of their compulsive behaviors.¹¹ However, the small sample size ($n = 22$) and the lack of details on important correlates, such as age at onset and severity and type of symptoms, limited our ability to conclusively interpret these previous findings. For instance, it is possible that reward (and by implication, habit) in OCD is restricted to only a particular subgroup of patients among checkers, washers, and arrangers.¹² This might have therapeutic importance, as different pharmacotherapies and cognitive-behavioral approaches that are effective in substance and behavioral addictions may theoretically benefit specific subgroups of OCD individuals (for a review, see Fontenelle *et al*¹³). For example, it is interesting to note that OCD patients with comorbid impulse control disorders have frequently been resistant to conventional anti-OCD treatments.^{1,14}

In this study, our objective was twofold. First, we aimed to determine the rates and self-report correlates of reward and habit in a larger sample of treatment-seeking OCD patients with a structured interview and a valid measure of habit strength. Second, we aimed to compare both the frequency of reward expectation and the strength of habit exhibited by patients who endorse washing, checking, and symmetry/ordering as their dominant compulsive symptoms. We have based our hypotheses on existing models postulating that, with progression and chronicity, OCD behaviors are increasingly valued to avoid the fear/anxiety through avoidance learning.¹³ According to this model, severe enduring OCD may at the same time become more habitual/automatic, because patients end up forgetting what the initial reasons for performing their OCD behaviors were, or rewarding, because such behaviors end up “hijacking” the reward system.¹³

We have found partial support for this model in a previous study with 1001 OCD patients, which reported that subjects with poor resistance, control, and insight over their compulsions were significantly more likely to have an addiction-like progression of their illness, with a deteriorative course; longer duration of obsessions; greater severity of contamination/cleaning, symmetry/ordering, and hoarding symptoms; and comorbid trichotillomania, intermittent explosive disorder, and compulsive buying.² Nevertheless, further links between OCD and addiction processes were compromised by the lack of assessment of positive affects and reward in this OCD sample. Thus, in this study, we hypothesize that both reward and habit would be frequent concomitants of OCD symptoms and would be associated with an early age at onset, longer duration of illness, greater severity of contamination/washing and symmetry/ordering symptoms, and comorbid impulse control disorders.²

Accordingly, we also hypothesized that washers and arrangers would exhibit greater levels of reward expectation and habit strength than checkers.

Methods

Seventy-three OCD consecutive patients who sought treatment in the Obsessive, Compulsive, and Anxiety Spectrum Research Program Clinic at the Institute of Psychiatry of the Federal University of Rio de Janeiro were enrolled in the study. This program clinic is the only specialized public service for the diagnosis and treatment of OCD spectrum disorders in the greater metropolitan Rio de Janeiro city area. The procedures involved in this research protocol were fully explained to patients (and when appropriate, to their family members), who signed an informed consent before being included in the study. The protocol was approved by the local ethics committee (Certificate of Submission for Ethical Assessment # 19596613.2.0000.5263).

Patients had their OCD diagnoses confirmed and other comorbid conditions assessed by means of the Structured Clinical Interview for DSM-IV Axis I disorders (SCID-I),¹⁵ which was supplemented with specific modules for the diagnoses of *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition, Text Revision (DSM-IV-TR) impulse control disorders. The presence of specific personality disorders deemed relevant for the purposes of this study (ie, borderline and obsessive-compulsive personality disorders) was also investigated using selected items from the Structured Interview for DSM-IV Personality (SIDP).¹⁶

Inclusion criteria included a diagnosis of “primary” OCD according to DSM-IV-TR criteria, age between 12 and 80 years, and the ability to read and complete forms. A “primary” OCD diagnosis was only established when the clinician judged obsessive-compulsive symptoms to be the most clinically significant ones as compared to other co-occurring conditions. If patients had other comorbid diagnoses thought to be more severe or to underpin their OCD, they were referred for treatment in other specialized clinics (eg, mood disorders clinic, substance abuse or rehabilitation units, and inpatient facilities), most frequently within the Institute of Psychiatry.

Temporal Impulsive Compulsive Scale–Revised (TICS-R)

The TICS-R is a semistructured interview that tracks the progression of positive, negative, and neutral affective states associated with different types of behaviors, whether repetitive or not. It quantifies emotions deemed to be critical for the characterization of behaviors as compulsive (or fear-based), impulsive (or reward-based), or both, while recognizing that the boundaries between

159 them are often blurred. The TICS-R conceptualizes
 160 behavior as being fear-based when there is a decrease in
 161 the experienced negative affect following the outward
 162 enacting of the target behavior (in the present case, an
 163 OCD-related behavior). In contrast, it conceptualizes
 164 behavior as being reward-based when there is a gain
 165 in the experience of positive affect in anticipation of
 166 enacting the OCD behavior.

167 The TICS-R was based on its initial self-report
 168 version, in which individuals responded on a visual
 169 analogue scale how intensely they experienced a selec-
 170 tion of 6 positive and 8 negative items from the PANAS
 171 before, in anticipation of, and after the last time they
 172 performed a target behavior.¹¹ However, this self-report
 173 version was found to be time-consuming and occasionally
 174 difficult to comprehend by the participants, particularly
 175 those with low education and/or insight, leading to the
 176 creation of this clinician-administered version.

177 In the newer, clinician-administered TICS-R, the
 178 original visual analogue scale was replaced by a 0 to 3
 179 Likert-type scale, and the PANAS items were collapsed
 180 into broad positive or negative affective states, wherein a
 181 “neutral” state (feeling “neither good nor bad” about
 182 the behavior) was added and a fourth “behavioral stage”
 183 (covering the emotional state experienced during the
 184 behavior of interest) was incorporated. Finally, since
 185 the same target behavior may not be invariably asso-
 186 ciated with a specific emotional valence, frequency
 187 (of PANAS items from a group of items) rather than
 188 intensity of affective states on individual PANAS items
 189 was chosen as the primary variable of interest. The
 190 TICS-R was specifically developed for behaviors that
 191 followed a (at least partial) conscious decision-making.
 192 For the purposes of this study, the target behavior was
 193 the patients’ most clinically significant OCD compulsion
 194 as reported by him or her and endorsed by his or her
 195 physician.

196 The TICS-R contains 4 sections corresponding to
 197 distinct temporal stages, each of which has 3 questions:
 198 (i) how frequently respondents had positive, negative, or
 199 neutral affective states *before they decide to perform*
 200 a target behavior (pre-decision stage); (ii) how frequently
 201 respondents *expected to have* positive, negative, or
 202 neutral affective states as a consequence of a target
 203 behavior (anticipatory stage); (iii) how frequently
 204 respondents had positive, negative, or neutral affective
 205 states *during* the performance of a target behavior
 206 (actual behavioral stage); and (iv) how frequently
 207 respondents had positive, negative, or neutral affective
 208 states *after* they performed a target behavior (consum-
 209 matory stage). Positive, negative, and neutral affective
 210 states were often referred to as “some sort” of
 211 “wellbeing,” “ill feeling,” or “neither good, nor bad
 212 feeling,” respectively. For each question, answers varied
 213 from 0 (never) to 3 (always) (see the Appendix).

*Self-Report Index of Habit Strength*¹⁷

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 215 Although repetition is a precondition for a habit to
 216 develop, the latter is a more complex concept for
 217 involving aspects of automaticity and identity.¹⁷
 218 Automaticity is based on the delegation of control over
 219 the behavior to the environment instead of to “conscious
 220 decision making.” It plays a critical role in how we
 221 organize our everyday life into routines¹⁸ and has
 222 3 important facets. First, the more a fragment of
 223 behavior is automatic, the more likely it is to be executed
 224 at the fringes of conscious awareness. Second, automatic
 225 behaviors are controllable only to a limited extent, ie,
 226 they can be difficult to override. Last, automaticity
 227 increases efficiency for freeing mental capacity to
 228 perform simultaneous non-routine activities—something
 229 that can be particularly desirable under stressful situa-
 230 tions (eg, when multitasking).

231 The Self-Report Habit Index (SRHI) measures how
 232 habitual a target behavior is. It contains 12 items to which
 233 respondents can agree or disagree from a rating of
 234 0 (completely disagree) to 7 (completely agree). The SRHI
 235 items cover the 3 core aspects of habits as described above,
 236 namely, the history of repetition (eg, “Behavior X is
 237 something ... I have been doing for a long time”), the level
 238 of automaticity (eg, “... I do without having to consciously
 239 remember”), and the relevance to self-identity (eg, “...
 240 that’s typically ‘me’”). The instrument has shown high
 241 1-week test-retest reliability and strong convergent valid-
 242 ity, as it correlated strongly and significantly with response
 243 and behavioral frequency measures.¹⁷

244 Importantly, the SRHI psychometric properties
 245 remained robust when the 3 items that refer to behavioral
 246 frequency were excluded, thus suggesting that reliability
 247 and validity were independent of how frequent a behavior
 248 is.¹⁷ In the same vein, for the purposes of our study,
 249 2 scores were calculated, ie, the traditional composite
 250 score, which sums up all 12 items’ responses, and an
 251 alternative score, which addresses Verplanken and
 252 Orbell’s¹⁷ concerns about circularity. The latter strategy
 253 excluded all items that were thought to conceptually
 254 overlap with compulsivity, while keeping items related to
 255 automaticity and identity (eg, “Behavior X is something ...
 256 that would require effort not to do it”). The objective of this
 257 alternative scoring method was to minimize measurement
 258 errors. In this study, the target behavior (or behavior X) was
 259 the patient’s most clinically significant compulsion.

Severity of obsessive-compulsive symptoms

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 261 Severity of global OCD symptoms and different OCD
 262 dimensions (ie, washing, checking, ordering, obsessing,
 263 hoarding, and neutralization) were assessed using
 264 the Obsessive-Compulsive Inventory-Revised (OCI-R), a
 265 self-report scale containing 18 items that quantify how
 266 distressed or bothered [0 (not at all) to 4 (extremely)]

267 respondents were by their OCD symptoms in the previous
 268 month. The Brazilian Portuguese version of the OCI-R has
 269 shown excellent test-retest reliability and moderate to
 270 good internal consistency and convergent/divergent
 271 validities.¹⁹

272 Since we were interested in a measure of the severity
 273 of compulsive behaviors, we specifically employed a
 274 modified version of the Compulsions subscale of the
 275 Yale-Brown Obsessive-Compulsive (Y-BOCS) Scale.²⁰
 276 The Y-BOCS is the most traditional instrument for the
 277 assessment of severity of OCD symptoms. Its “compul-
 278 sive” subscale contains 5 sub-items covering time spent
 279 with compulsions, interference caused by compulsions,
 280 anxiety or distress if the subject is prevented from
 281 performing compulsions, resistance toward compul-
 282 sions, and control over compulsions. In our research,
 283 only the severity of the main compulsive behavior was
 284 measured. Each item is scored on a scale from 0 to 4,
 285 the compulsions subscore maximum being 20.

286 *Other instruments*

287 Given that the TICS-R is a newly developed instrument,
 288 we employed a series of other instruments to compre-
 289 hensively measure constructs related to reward and fear.
 290 Among the first group, we included the Temporal
 291 Experience of Pleasure Scale (TEPS)²¹ to assess the
 292 subjects’ ability to experience anticipatory and consum-
 293 matory pleasure. The anticipatory subscale of the TEPS
 294 should correlate with increases in positive affect follow-
 295 ing reward anticipation on the TICS-R, while the
 296 consummatory subscale should correlate with total
 297 positive affect during performance of the compulsion.
 298 Similarly, the Behavioral Activation Scale (BAS)²² taps
 299 proneness to move toward something desired and should
 300 correlate with reward anticipation on the TICS-R. The
 301 positive urgency dimension of the Urgency, Premedita-
 302 tion, Perseverance, Sensation seeking, and Positive
 303 Urgency Impulsive Behavior Scale (UPPS-P) Impulsive
 304 Behavior Scale²³ should also correlate with total positive
 305 affect associated with the compulsion. Conversely, to
 306 assess aspects related to fear, negative affect, and habit
 307 strength, the Behavioral Inhibition Scale (BIS)²² was
 308 chosen to measure the propensity to move away from
 309 something unpleasant; the Intolerance of Uncertainty
 310 Scale (IUS-12)²⁴ was used to measure intolerance of the
 311 notion that negative events may occur and there is no
 312 perfect way of predicting such events; and the Obsessive
 313 Beliefs Questionnaire (OBQ-44)²⁵ was employed to
 314 measure dysfunctional beliefs thought to be important
 315 for the development and maintenance of OCD.

316 *Statistical analyses*

317 To investigate the self-report correlates of reward and
 habit in OCD patients, we performed Pearson’s

correlation between both the TICS (pre-choice, antici- 318
 patory, behavioral, and consummatory stages), and the 319
 SRHI scores with aspects related to course of OCD (age 320
 at onset and duration of illness) and with scores/ 321
 subscores from the OCI-R, Y-BOCS, TEPS, UPPS-P, 322
 BIS/BAS, IUS-12, and OBQ-44 scales. 323

We also performed a linear regression analysis using 324
 the SRHI as a dependent factor and psychopathological 325
 features, such as comorbid axis I and II psychiatric 326
 disorders and all the remaining self-report measures, as 327
 independent factors to identify which features were 328
 critical for the determination of how habitual an OCD 329
 behavior may be. 330

To compare patients who endorse washing (washers), 331
 checking (checkers), and symmetry/ordering (arrangers) 332
 as their main compulsive symptom on the progression of 333
 positive, negative, and neutral affective states through- 334
 out the 4 TICS-R stages, we have performed a $3 \times 3 \times 4$ 335
 repeated measures General Linear Model. We also 336
 performed correlations between duration of illness (in 337
 years) and positive affects across each stage in according 338
 to the TICS-R separately in washers, checkers, and 339
 arrangers. 340

Finally, the 2 SRHI scores across patients who endorse 341
 washing, checking, and symmetry/ordering as their 342
 main compulsive symptom were compared using analysis 343
 of variance (ANOVA). Separate correlations between 344
 duration of illness (in years) and the SRHI scores in 345
 washers, checkers, and arrangers were also performed. 346
 The level of statistical significance (α) was set at .05, 347
 two-tailed. All analyses were performed with the SPSS 348
 20.0 software. 349

350 *Results*

Thirty-six OCD patients (49.3%) described frequently or 351
 always expecting gains in positive affect (or reward) with 352
 the realization of their main compulsive behavior. We 353
 found correlations between the TICS anticipatory/ 354
 consummatory scores and the TEPS anticipatory/con- 355
 summatory pleasure scores to be moderate ($r = 0.25$ and 356
 $p = 0.03$, $r = 0.27$ and $p = 0.02$, respectively). The lack 357
 of correlation between the TICS and measures other than 358
 the TEPS is consistent with its satisfactory divergent 359
 validity (see the Supplementary Material, available 360
 online). Conversely, the 2 SRHI scores correlated 361
 positively with indexes of OCD severity and the main 362
 symptom severity, namely the OCI-R total score ($r = 0.45$; 363
 $p < 0.001$ and $r = 0.37$; $p = 0.002$) and the Y-BOCS 364
 compulsions subscores ($r = 0.50$; $p < 0.001$ and $r = 0.41$; 365
 $p = 0.001$), respectively. The results of our regression 366
 analysis indicated that severity of compulsions and 367
 comorbidity with impulse control disorders significantly 368
 predicted 26–35% of the variance of the SRHI scores, 369
 depending on the scoring method (Table 1). 370

TABLE 1. Stepwise regression analyses with the Self Report Habit Index (SRHI) scores as the dependent variables

Variables of interest	B	SE	Standardized beta	t	Significance
SRHI - conventional scoring ($R^2 = .35$)					
Y-BOCS compulsions score	1.84	.41	.47	4.45	$P < .001$
Impulse control disorders	9.90	3.16	.33	3.13	$P = .003$
SRHI - alternative scoring* ($R^2 = .26$)					
Y-BOCS compulsions score	1.11	.33	.38	3.35	$P \leq .001$
Impulse control disorders	7.44	2.54	.33	2.92	$P = .005$

SRHI: Self Report Habit Index.
* Scoring without overlapping items.

TABLE 2. Comparison of the socio-demographic and clinical features between the 3 OCD groups

Variables of interest	Checkers (n = 19)	Washers (n = 19)	Arrangers (n = 28)	Results
Age, in years (SD)	43.37 (14.97)	40.11 (14.31)	40.82 (15.97)	$F = 0.26$; $df = 65$; $p = 0.76$
Gender (male, %)	11 (57.9%)	9 (47.9%)	16 (57.1%)	$\chi^2 = 0.55$; $df = 2$; $p = 0.75$
Age at onset, in years (SD)	19.53 (11.92)	17.42 (8.66)	14.07 (10.62)	$F = 1.60$; $df = 65$; $p = 0.21$
Duration, in years (SD)	23.84 (15.22)	22.68 (18.35)	26.75 (17.82)	$F = 0.35$; $df = 65$; $p = 0.70$
OCI-R total	28.47 (16.26)	31.00 (15.45)	32.25 (13.99)	$F = 0.35$; $df = 65$; $p = 0.70$
Y-BOCS compulsions	11.84 (3.79)	13.26 (3.08)	13.07 (3.88)	$F = 0.88$; $df = 65$; $p = 0.41$

OCI-R: Obsessive-Compulsive Inventory-Revised; Y-BOCS: Yale-Brown Obsessive-Compulsive Scale.

371 Next, we compared reward and habit across OCD
372 groups. Specifically, we found that 19 OCD patients had
373 primary checking, 19 had washing, and 28 had symme-
374 try/ordering symptoms as their most clinically signifi-
375 cant compulsions. Seven patients were excluded for
376 having main compulsive symptoms that were not overt or
377 motor (eg, mental compulsions) or not very well
378 represented in the sample (eg, 2 patients endorsed
379 “hoarding” as the main symptom). As can be seen in
380 Table 2, no significant differences between washers,
381 checkers, and arrangers in terms of socio-demographic
382 features were noted.

383 Among washers, the prevalence of patients who
384 always or frequently expected obtaining reward from
385 their behaviors (n = 15; 78.9% of the subsample) was
386 significantly higher than among checkers (n = 5; 26.3%)
387 or arrangers (n = 13; 46.4%) ($\chi^2 = 10.7$; $df = 2$;
388 $p = 0.005$). There were also interactions between affective
389 valence (positive, negative, and neutral) and OCD
390 groups (washers, checkers, and arrangers) [$F(3.8,$
391 $119.0) = 4.8$; $p = 0.002$]; between TICS-R stage (pre-
392 choice, anticipatory, behavioral, and consummatory)
393 and OCD group [$F(6.0, 189.0) = 2.2$; $p = 0.04$];
394 between affective valence and TICS-R stage [$F(3.2,$
395 $200.0) = 52.0$; $p < 0.001$]; and between OCD group,
396 affective valence, and TICS stage [$F(6.3, 200) = 2.6$;
397 $p = 0.01$]. As seen in Figure 1, OCD washers exhibited a
significant increase of the positive affect in the

anticipatory and consummatory stages as compared to
the other OCD groups.

Although no significant correlation between duration of
illness and TICS-R responses in the whole sample was
found (see Supplementary Material), very significant
correlations between positive affect during and after
compulsive behaviors according to the TICS-R and dura-
tion of illness ($r = 0.61$, $p = 0.006$; $r = 0.49$, $p = 0.032$,
respectively) were found in washers but not in patients
showing other subtypes of compulsions (see Table 3).

The 3 OCD groups did not differ in terms of SRHI
scores according to the traditional [$F(2,63) = 0.61$;
 $p = 0.54$] and alternative systems [$F(2,63) = 0.30$;
 $p = 0.73$], the latter without OCD-like items (Figure 2).
Although duration of illness did not emerge as a significant
predictor of SRHI scores in the whole sample (Table 1), we
have also assessed the correlations between duration of
illness and SRIHS across different groups (washers,
checkers, and arrangers). We found significant correla-
tions between different SRHI scoring methods and
duration of illness ($r = 0.55$, $p = 0.01$; $r = 0.50$,
 $p = 0.03$) that were restricted to checkers, and not
reported in other groups (Table 3).

Discussion

The main finding of this study was that almost half of our
treatment-seeing OCD patients reported frequently or

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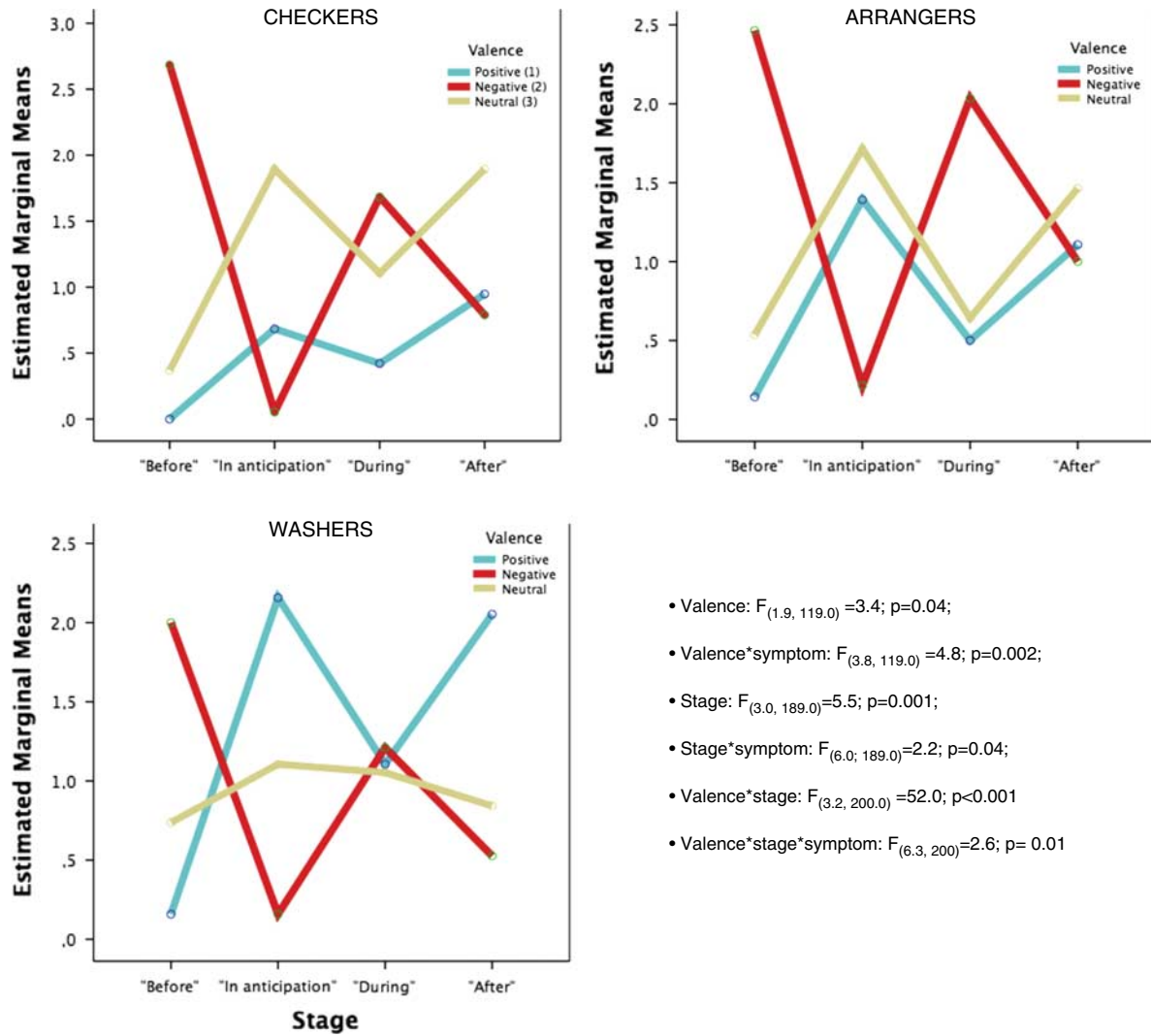


FIGURE 1. Comparison between the progression of affective states by checkers, arrangers, and washers according to the Temporal Impulsive-Compulsive Scale-Revised.

TABLE 3. Correlations between duration of symptoms, positive affects, and habitual features according to the main OCD group

Variables of interest	Duration of symptoms		
	Checkers (n = 19)	Washers (n = 19)	Arrangers (n = 28)
TICS-R Positive affect			
Before	—	$r = -0.39$ ($p = 0.10$)	$r = -0.25$ ($p = 0.19$)
In anticipation	$r = 0.10$ ($p = 0.66$)	$r = 0.23$ ($p = 0.33$)	$r = -0.17$ ($p = 0.37$)
During	$r = 0.16$ ($p = 0.52$)	$r = 0.61$ ($p = 0.006$)**	$r = -0.27$ ($p = 0.16$)
After	$r = 0.09$ ($p = 0.72$)	$r = 0.49$ ($p = 0.03$)*	$r = -0.11$ ($p = 0.56$)
SRHI			
Traditional score	$r = 0.55$ ($p = 0.01$)*	$r = 0.04$ ($p = 0.87$)	$r = -0.14$ ($p = 0.47$)
W/out OCD-like items	$r = 0.50$ ($p = 0.03$)*	$r = -0.01$ ($p = 0.95$)	$r = -0.21$ ($p = 0.27$)

TICS-R: Temporal Impulsive-Compulsive Scale-Revised; SRHI: Self Report Index of Habit Strength; (—): cannot be computed because one variable is a constant. * $p < .05$; ** $p < .01$, *** $p < .001$.

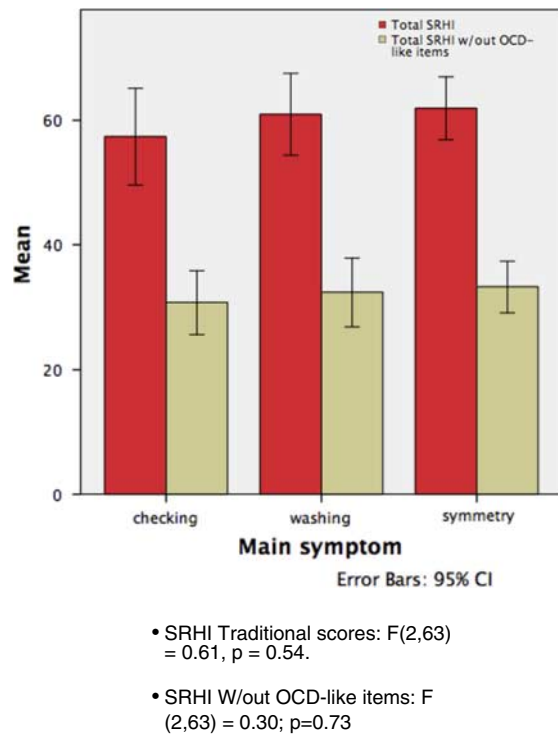


FIGURE 2. Comparison between checkers, washers, and arrangers in the Self Report Index of Habit Strength, traditional and alternative scoring systems.

424 always expecting to experience gains in positive affect
 425 from the enactment of their compulsive behaviors. Thus
 426 anticipation of reward may drive compulsive symptoms
 427 in a significant subset of OCD patients. In fact, some
 428 researchers have already conceptualized OCD compul-
 429 sions as addictive because of their apparent rewarding
 430 effects that follow the reduction of obsession-induced
 431 anxiety.⁹ Although correlations between the frequency of
 432 reward anticipation and other self-report correlates of
 433 reward and punishment were only small to moderate, we
 434 also noted that washers differed from checkers and
 435 arrangers in the trajectories of their experiences of
 436 positive, negative, and neutral affect associated with the
 437 target compulsive symptoms by exhibiting significant
 438 gains in positive affect in anticipation of the performance
 439 of their OCD behaviors. Washers also stood out in that
 440 their positive affects *during* and *after* compulsive
 441 behaviors were highly (and positively) correlated with
 442 duration of illness—a finding that could also explain why
 443 they expect to obtain rewards with washing.

444 Our findings suggest that, as OCD progresses,
 445 washing behaviors end up being more rewarding. This
 446 phenomenon is in accordance to our previous hypoth-
 447 esis.^{2,13} In fact, washing may be unique among other
 448 OCD dimensions. Rachman,²⁶ for instance, suggested
 449 that, “When the fear (of contamination) is evoked,
 450 usually by direct contact with a perceived contaminant, it
 451 immediately generates a powerful, even overwhelming,

urge to clean. The urge is generally so strong that it over-
 452 rides other considerations” (p. 1238). However, it is
 453 unclear whether intensity of urge is linked to reward
 454 anticipation. One could argue that the prospects of
 455 feeling clean (or sometimes “pure” or even “immacu-
 456 late”) may be particularly rewarding for an OCD washer.
 457 In fact, in a previous study, washing (and symmetry)
 458 symptoms were over-represented among OCD patients
 459 who, besides having low insight, fail to resist and to
 460 control performing their compulsions.² Other studies
 461 have also reported that washing is particularly common
 462 in OCD that develops after posttraumatic stress dis-
 463 order²⁷ or comorbid with borderline personality dis-
 464 order,²⁸ two conditions known to predispose sufferers to
 465 substance addiction.²⁹

466 There are also neurobiological findings to suggest that
 467 association between OCD washing and reward anticipa-
 468 tion may be linked to brain deficits in reward processing⁹
 469 and altered dopaminergic neurotransmission.³⁰ One
 470 study reported that OCD patients were less able than
 471 healthy controls to activate the nucleus accumbens
 472 bilaterally and the left insula during anticipation of gains
 473 in a monetary incentive task. Importantly, this study also
 474 found that OCD with contamination/washing dimension
 475 symptoms displayed lower activity within these areas
 476 when compared with OCD patients with the shameful-
 477 checking symptom dimensions.⁹ Accordingly, we have
 478 previously found that one $-287A > G$ catechol-
 479 Omethyltransferase polymorphism, which may be related
 480 to altered dopaminergic transmission and has been
 481 already associated with heroin addiction, was also
 482 significantly over-represented among female subjects
 483 with washing symptoms and male individuals with
 484 symmetry symptoms.³⁰

485 We also discovered moderate to high positive correla-
 486 tions between the severity of OCD (including OCI-R total
 487 scores and Y-BOCS compulsions scores) and habit
 488 strength using the both the SRHI’s traditional scoring
 489 system ($r = 0.46; p < 0.001$) and one that excluded items
 490 thought to overlap conceptually with compulsivity (ie,
 491 “that would require effort not to do it”) ($r = 0.36;$
 492 $p = 0.001$). These findings reinforce the association
 493 between OCD’s compulsive behaviors and habits. Import-
 494 antly, however, our findings suggest that OCD compul-
 495 sions and habits are not simply redundant constructs.
 496 This is the first confirmation, on a phenomenological
 497 level, that OCD compulsions can display habitual
 498 features, as previously suggested by several laboratory
 499 experiments (for a review see Gillan and Robbins⁷).
 500 Although we noted that the strength to which a specific
 501 compulsive behavior is habitual did not depend on the
 502 compulsion type (washing, checking, or arranging), our
 503 findings suggest that checkers differ from other groups
 504 by having symptoms that become increasingly habitual
 505 with the progression of OCD. Thus, it seems that,
 506

507 after some time, checking may just need to be followed
508 without inducing much emotion or being linked to any
509 goal-driven motivations.

510 The results of our regression model not only
511 supported the relationships between habit strength and
512 severity of compulsions but also expanded them by
513 showing that the latter, coupled with comorbidity with
514 impulse control disorders, predicted a substantial
515 amount (26–35%) of the variability in SRHI scores.
516 Thus, comorbid impulse control disorders also may
517 shape the expression of OCD compulsions by imparting
518 them habitual contours, including greater “automati-
519 city,” expression of one’s identity, and, as expected, a
520 history of repetition.¹⁷ These findings are also consistent
521 with evidence that OCD patients with broadly defined
522 impulse control disorders express different characteris-
523 tics, including earlier age at OCD onset, a more insidious
524 appearance of OCD symptoms, a higher rate of comorbid
525 anxiety disorders, a greater number and severity of
526 compulsive symptoms, and a higher number of required
527 serotonin reuptake inhibitor (SRI) trials.¹ Similar find-
528 ings were reported elsewhere.¹⁴ Thus, it seems intuitive
529 to test whether strategies involving habit reversal could
530 help OCD patients exhibiting more severe compulsive
531 symptoms and/or comorbid impulse control disorders.

532 Instrumental behaviors are generally classified into
533 (i) goal-directed (or “model-based”) behaviors that are
534 planned and purposefully performed to avoid punish-
535 ment (negative reinforcement) or to achieve reward
536 (positive reinforcement) or (ii) habitual (or “model-
537 free”) behaviors that are inflexibly and automatically
538 performed in response to environmental stimuli.^{31,32}
539 Though OCD is generally considered goal-directed,³³
540 we speculate that OCD compulsions may lay half way
541 between model-based behaviors’ and model-free behav-
542 iors’ brain systems [based on ventral (caudate) and
543 dorsal (putamen) striatum, respectively]. In fact, our
544 findings suggest that, with OCD progression, washing
545 may become more rewarding (by involving more ventral
546 systems) and checking may become more habitual (by
547 involving more dorsal systems). Although some studies
548 have conceptualized OCD’s compulsive behaviors as
549 arising from a generalized bias toward forming habits,
550 which have been ascribed, for instance, to lower gray
551 matter volumes in the caudate and medial orbitofrontal
552 cortex (eg, Voon *et al*³⁴), these studies differed from ours
553 as they relied on neurocognitive tests measuring indivi-
554 duals’ abilities to learn habits instead of the *pathological*
555 behaviors (or habits) per se.

556 Our study is not without limitations. First, we acknowl-
557 edge that our approach might be considered too exploratory
558 for performing multiple comparisons without
559 appropriate corrections. However, we also believe that,
560 given the current state of knowledge and the prevailing
561 lack of information on the correlates of reward and habit in

OCD, it is advisable to be more lenient than usual.³⁵ The
TICS-R is still preliminary in terms of psychometrics and
may not have covered all phenomenological facets of
compulsivity and impulsivity (as reviewed in Arzeno Ferrao
*et al*³⁶). Also, some patients might have underreported
more automatic or reward-related behaviors, which are
often performed on the fringes of consciousness. Further,
the fact that the rates of anticipation of reward in the
present investigation were substantially lower than the
ones reported in our pilot study suggests that the under-
lying construct of reward in OCD may be unstable.¹¹
However, it may well reflect adjustments made in the
instrument used to assess affective states, including a
clinician administered-format that provided greater flex-
ibility to assess patients’ responses; the inclusion of a
neutral (neither “good nor bad”) affective state question
that allowed some OCD patients to report that, by
performing their compulsive behaviors, they aimed to
become “neutral” (and not necessarily “good”); and the
use of frequency rather than intensity of emotions as
anchors, as patients may base their reports on exceptional
increases in positive affect in anticipation of compulsive
symptoms that do not reflect the affective makeup of their
target behaviors.

586 Conclusions

OCD, addiction, impulse control disorders, and habits are
closely related phenomena. Compulsive washers may be
more clearly characterized by problems in reward proces-
sing. In contrast, the duration of checking, severity of
OCD, and comorbidity with impulse control disorders
may shape compulsive behaviors by imparting them with
habitual features. These findings may bear treatment
implications for OCD patients with compulsive washing,
who may be the subjects of future controlled trials of anti-
craving medications (such as naltrexone or nalmefene³⁷)
or other psychological interventions potentially relevant
for the treatment of other addictive behaviors (such as
contingency management or motivational interviewing³⁸),
and to patients with severe OCD comorbid with impulse
control disorders and/or chronic checking behaviors, who
may be tested for alternative behavioral techniques, such
as habit reversal.³⁹

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612 **Supplementary material**

613 For supplementary material/s referred to in this article,
614 please visit <https://doi.org/10.1017/S1092852916000535>

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Appendix: Temporal Impulsive-Compulsive Scale–Revised (Fontenelle, Ferreira, & Yücel, 2013)

“For the next questions, I would like you to think about how you feel in relation to _____. Specifically, I would like to know how you feel before deciding to _____, what you expect to feel as a result of _____, how you feel during _____ and what do you feel after. Try to think about how do you feel in each one of these moments. (NOTE TO THE INTERVIEWER: WAIT A FEW SECONDS BEFORE PROCEEDING)”

1) Firstly, I would like you to think about the emotions you feel **before deciding to** _____. (NOTE TO THE INTERVIEWER: WAIT A FEW SECONDS BEFORE PROCEEDING)
How frequently...

	Never	Sometimes	Frequently	Always
1.1. ... do you feel any type of positive or good emotions before deciding to _____?	0	1	2	3
1.2. ... do you feel any type of negative or bad emotions before deciding to _____?	0	1	2	3
1.3. ... do you feel neutral (neither good, nor bad) before deciding to _____?	0	1	2	3

2) What about when you decide to _____? What kind of feelings do you **expect to have**? To be clear, I would like you to think about what you **expect to feel** as a result of _____. (NOTE TO THE INTERVIEWER: WAIT A FEW SECONDS BEFORE PROCEEDING)
How frequently...

	Never	Sometimes	Frequently	Always
2.1. ... do you expect to feel any type of positive or good emotions when deciding to _____?	0	1	2	3
2.2. ... do you expect to feel any type of negative or bad emotions when deciding to _____?	0	1	2	3
2.3. ... do you feel neutral (neither good, nor bad) when deciding to _____?	0	1	2	3

3) What about **DURING** the moment you are _____? I really want you now to focus on the actual moments during which you are _____ (NOTE TO THE INTERVIEWER: WAIT A FEW SECONDS BEFORE PROCEEDING)
How frequently...

	Never	Sometimes	Frequently	Always
3.1. ... do you feel any type of positive or good emotions during the times you are _____?	0	1	2	3
3.2. ... do you feel any type of negative or bad emotions during the times you are _____?	0	1	2	3
3.3. ... do you feel neutral (neither good, nor bad) during the times you are _____?	0	1	2	3

4) Finally, how do you usually feel in the moments immediately **AFTER** you actually _____? (NOTE TO THE INTERVIEWER: WAIT A FEW SECONDS BEFORE PROCEEDING)
How frequently...

	Never	Sometimes	Frequently	Always
4.1. ... do you feel any type of positive or good emotions after you _____?	0	1	2	3
4.2. ... do you feel any type of negative or bad emotions after you _____?	0	1	2	3
4.3. ... do you feel neutral (neither good, nor bad) after you _____?	0	1	2	3