Psychological traits and platelet monoamine oxidase activity in eating disorder patients: Their relationship and stability

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Abstract

Self-reported behavior and attitudes towards eating [Eating Disorder Inventory-2; Garner DM (1991). Eating Disorder Inventory-2: Professional Manual. Odessa, Fl.: Psychological Assessment Resources; Estonian version Podar I, Hannus A, Allik J (1999). Personality and Affectivity Characteristics Associated With Eating Disorders: a Comparison of Eating Disordered, Weight-Preoccupied, and Normal Samples. J Pers Assess; 73(1), 133–147] and the activity of platelet monoamine oxidase (MAO) was studied in 11 patients with anorexia nervosa (AN), 43 patients with bulimia nervosa (BN) and a healthy control group (n = 138). Nineteen patients filled in the EDI-2 questionnaire and donated blood samples three times with three month intervals in order to determine platelet MAO activity. Eating disordered (ED) patients scored higher on all EDI-2 subscales and had lower MAO activity compared to the control group. They also scored higher than the control group on the Neuroticism domain but lower on the Extraversion, Openness, and Conscientiousness domains of the NEO-PI-R questionnaire. The average stability of MAO on different occasions (r = .56) was slightly smaller than the stability of the EDI-2 scores (r = .70). The lack of correlations between personality dispositions and MAO activity indicates that they have independent influence on eating disorders. A possible relationship between neurochemical mechanisms and psychological symptoms of eating disordered behavior is discussed.

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1. Introduction

Since eating disordered behavior is more prevalent in industrialized and Western societies, culture has been identified as one of the major etiological factors leading to the development of anorexia nervosa (AN) and bulimia nervosa (BN) (Miller and Pumariega, 2001). Furthermore, because these syndromes are far more common among females than males and they have become more common among younger females during the latter half of the twentieth century it is believed that they are reflecting current cultural beauty ideals for women (Miller and Pumariega, 2001; Keel and Klump, 2003). Although eating disorders have socio-cultural (e.g., family influences and cultural pressures for thinness) risk factors there are also psychological (e.g., personality dispositions) (Fairburn and Harrison, 2003; Mussell et al., 2000) and neurochemical mechanisms involved in the development of eating disordered behavior (Brewerton, 1995).

Like many other obsessive compulsive behaviors, eating disorders demonstrate a high degree of stability over time (Joiner et al., 1997; Kotler et al., 2001; Mecarthy et al., 2002; Rastam et al., 1996; Rizvi et al., 1999). Early adolescent bulimia nervosa is associated with a 9-fold increase in risk for late adolescent bulimia nervosa and a 20-fold increase in risk for adult bulimia nervosa. Late adolescent bulimia nervosa is associated with a 35-fold increase in risk for adult bulimia nervosa. Presence of eating
problems in early childhood or an eating disorder in adolescence confers a strong risk for an eating disorder over a 17-year interval (Kotler et al., 2001). Bulimic symptoms measured by Eating Disorder Inventory (EDI-2; Garner, 1991) administered 10 years earlier display high temporal stability (Joiner et al., 1997; Heatherton et al., 1997). Contrary to the commonly held belief that disturbed eating attitudes decline with age, the mean scores on eating disorder attitude scales tended to increase with age (Rizvi et al., 1999). Therefore it is not surprising that different instruments like Eating Disorder Inventory (EDI, Garner, 1991) also demonstrate a good test–retest stability. For example, in a non-clinical sample EDI demonstrated a substantial stability over a 1 year period (Crowther et al., 1992). Although developed for adults, EDI-2 scales demonstrated considerable test–retest stability also in a sample of adolescents over a 3 year period (Mccarthy et al., 2002). An acceptable test–retest stability was also observed in samples of eating disordered patients (Rizvi et al., 1999; Tasca et al., 2003). Only the scores for the EDI-scale “drive for thinness” were found to change significantly over multiple administrations (Percevic et al., 2004).

Although the stability of eating disordered behaviors and attitudes suggests the enduring role of personality dispositions in the development of eating disorders, it is not entirely clear what combination of personality traits contribute as a risk factor (Cassin and Von Ranson, 2005; Steiger and Bruce, 2004; Wonderlich and Mitchell, 2001). The best documented link exists between neuroticism and eating disorders (Brewerton et al., 1993; Cassin and Von Ranson, 2005; Diaz-Marsa et al., 2000b; Brookings and Wilson, 1994; Davis et al., 1997; Pollock-Barziv and Davis, 2005). However, the role of other personality dispositions in the etiology of eating disorders is less clear. Increasing evidence indicates that normal and abnormal personality can be treated within a single hierarchical structure in which the level of five factors is the most comprehensive (Markon et al., 2005). Unfortunately, the number of studies of eating disorders in the framework of the Big Five personality factors is limited (Bollen and Wojciechowski, 2004; Ghaderi and Scott, 2000; Podar et al., 1999; Brookings and Wilson, 1994; Tylka and Subich, 1999; Claes et al., 2004). Nevertheless, findings seem to suggest that eating disorder symptomatology is correlated with high neuroticism and openness to experience and low conscientiousness and agreeableness (Brookings and Wilson, 1994; Cassin and Von Ranson, 2005; Podar et al., 1999). Unfortunately, there is no complete agreement between different studies. For example, Ghaderi and Scott (2000) found that among 1157 women randomly selected from the general population a high level of openness, not closeness, was significantly associated with self-reported lifetime history of eating disorder.

Besides phenotypical personality traits, that can be conceptualized as biologically rooted endogenous dispositions (McCrae and Costa, 1996, 1999), the disturbances in the underlying neurochemical systems may be another risk factor for eating disorders. In particular, patients with eating disorders exhibit serotonin (5-hydroxytryptamine, 5-HT) dysregulation (Brewerton, 1995; Steiger, 2004). Several studies have confirmed that patients with AN or BN demonstrate reduced activity of platelet monoamine oxidase (MAO) activity which is a reliable peripheral indicator of the central serotonin activity (Biederman et al., 1984; Carrasco et al., 2000; Diaz-Marsa et al., 2000a; Hallman et al., 1990; Verkes et al., 1996). The role of serotonin dysregulation in the development of eating disorders is also demonstrated by a significant improvement of AN and BN patients who have been treated with the serotonin reuptake inhibitor citalopram (Pallanti et al., 1997; Mceloey et al., 2003; Landen et al., 1999; Sundblad et al., 2005).

Although both, personality dispositions and serotonin system dysfunction, contribute to the eating disorders, there are relatively few studies in which these two groups of factors are jointly studied in the clinical and normal samples. Existing data, however, demonstrate that there may be a covariation between personality traits and neurochemical activity in the brain. For example, Steiger et al. (2005) demonstrated a covariation between personality traits and 5-HT indices in bulimic patients. These findings suggest a multidimensional model of eating disorders according to which biological and personality dispositions jointly interact in the development of eating disorders (Steiger, 2004; Steiger et al., 2005). This study is a continuation of attempts to study in parallel the influence of personality dispositions and the activity of the serotonin system on the eating behavior and attitudes. Another novelty of this study is a longitudinal observation of self-reported behavior and attitudes towards eating in parallel with MAO activity three times with three months intervals.

2. Methods

2.1. Participants

Altogether one hundred and ninety two subjects from two different groups participated in this study.

2.1.1. Eating disordered patients

Fifty four patients with eating disorders who were consecutively admitted to the Psychiatric Clinic of Tartu University Hospitals between March 2000 and March 2003 took part in this study, among them 11 cases met the criteria for anorexia nervosa (F 50.0) and 43 cases for bulimia nervosa (F 50.2). The patients were diagnosed based on the criteria of the Classification of Mental and Behavioural Disorders (International Classification of Diseases-10; World Health Organization, 1992). The patients were diagnosed by experienced psychiatrists. Twenty one patients were diagnosed having co-morbidity symptoms, most frequently depression (F 32.0) in 15 cases. However, only in 2 cases depressive episodes were severe (F 32.2). Two patients were diagnosed with recurrent depressive disorder (F 33.1). In 2 cases, both bulimics, a harmful use or dependence on alcohol was recorded (F 10). In one case social phobias (F 40.1) were reported. Forty patients (74%) received antidepressant treatment. In most cases (30 patients) Fluoxetine (20 mg/day) or some other antidepressants like Paroxetin or Citalopram (9 cases) were prescribed from one to twelve months. In 1 case anxiolytic Xanax was prescribed. All patients received at least once psychiatric consultation concerning eating disorders, dieting, and nutrition and were encouraged to start treatment. Three patients attended sessions of cognitive-behavioral therapy (at least 10
sessions). All participants were females aged 16–37 years (mean = 20.1; S.D. = 4.5) and their mean body mass index (BMI; the body weight in kilograms divided by the squared height in meters) was 19.77 (S.D. = 2.8). Eleven patients were smokers.

2.1.2. Control group

The control group (n = 138) was also entirely comprised of females aged 16–37 years (mean = 20.14; S.D. = 3.33) and their BMI was 20.47 (S.D. = 2.45). The control group was selected from the students of Tartu University and other schools, employees of the Psychiatric Clinic and others, who volunteered to participate in the research project. The control group was selected to match the eating disordered patients by their sex, age, and education. Thirteen participants from the control group were smokers.

2.2. Measures

2.2.1. Eating disorder inventory- 2

The Estonian version (Podar et al., 1999) of the Eating Disorder Inventory-2 (EDI-2; Garner, 1991) consists of 91 items and 11 subscales measuring psychological characteristics and behaviors associated with eating disorders. The items are evaluated on a 6-point scale (from “never” to “always”) which for the analysis is transformed into a 4-point scale. Like its predecessor, EDI-2 consists of 8 primary scales: DT — Drive for Thinness, B — Bulimia, BD — Body Dissatisfaction, I — Ineffectiveness, P — Perfectionism, ID — Interpersonal Distrust, IA — Interoceptive Awareness, and MF — Maturity Fears. In the second revision EDI-2 consisted of 3 additional scales were developed: A — Asceticism, IR — Impulse Regulation, and SI — Social Insecurity. The first 3 subscales are concerning eating, weight and body shape (DT, B, BD), and eight subscales concerning psychological traits thought to be clinically relevant to eating disorders (I, P, ID, IA, MF, A, IR, SI). The diagnostic validity of the Estonian EDI-2 has been previously demonstrated (Podar et al., 1999; Fetissov et al., 2005).

2.2.2. Revised NEO Personality Inventory

The Estonian version (Kallasmaa et al., 2000) of the Revised NEO Personality Inventory (NEO-PI-R) is a 240-item measure of the Five Factor Model of personality (Costa and McCrae, 1992). It contains 30 8-item facet scales, six for each of the five basic personality factors, Neuroticism (N), Extraversion (E), Openness to Experience (O), Agreeableness (A), and Conscientiousness (C). The factors can be estimated by domain scores, which sum the relevant six facets. The original NEO-PI-R was translated and adapted into Estonian with all psychometrically significant parameters similar to the original instrument (Costa and McCrae, 1992). In the previous report of Estonian EDI-2 (Podar et al., 1999) an older version of the NEO-PI was used (Pulver et al., 1995). Estonian NEO-PI-R data have repeatedly been reported in different publications and demonstrate an acceptable validity (Allik and McCrae, 2004; Allik, 2005).

2.2.3. MAO-B Activity

One hundred and six individuals from the control group gave blood samples for determining their MAO-B activity. MAO activity was measured as previously described (Harro et al., 2001) and expressed as nanomoles of β-phenylethylamine oxidized per 1010 platelets/min. On the first time all the patients participating in the research were tested for MAO activity (n = 54), blood samples from 34 and 26 patients, respectively, were available at follow-up three months or six months later.

2.3. Procedure

Patients who volunteered to participate were asked to fill in the EDI-2 Estonian version and have their blood tested for the activity of monoamine oxidase three times with an interval of three months. Forty eight filled EDI-2 questionnaires were returned on the first time, 26 on the second and 19 on the third. Nineteen patients returned the filled questionnaires and had MAO activity tested all three times.

3. Results

Internal consistency of the EDI-2, both in clinical and control samples, was similar and in the range of reliabilities reported in the EDI-2 manual (Garner, 1991). In the control group (n = 138) alpha was .84 and in the patient group (n = 54) alpha was .88.

Fig. 1 shows the mean values on EDI-2 scales for the three categories of participants: AN and BN patients and the control group. When treated as a single category, ED patients scored significantly higher on all EDI-2 scales compared to the control group (F values in ANOVA varied from F(1, 182) = 8.08 to 79.90 for the Perfectionism and Ineffectiveness subscales respectively, p always higher than .003). In comparison with each other, anorexia and bulimia patients differed significantly only on the B subscale (F(1, 44) = 11.64, p < .001) where bulimia patients scored higher than the anorexia patients.

Fig. 1. The mean scores of EDI-2 subscales for controls (n = 138), anorexia patients (AN; n = 11) and bulimia patients (BN; n = 37). EDI-2 subscales: DT = Drive for Thinness; B = Bulimia; BD = Body Dissatisfaction; IE = Ineffectiveness; P = Perfectionism; ID = Interpersonal Distrust; IA = Interoceptive Awareness; MF = Maturity Fears; A = Asceticism; IR = Impulse Regulation; SI = Social Insecurity.
higher than anorexia patients. The difference on the BD subscale was only marginally significant \(F(1,45)=4.08; p=.049\).

The average profile of ED patients was very similar to what was obtained in other countries. When the correlations were computed between the EDI-2 subscale profile obtained in this study and profiles of ED patients reported in the literature, they were typically in the range from .90 to .98 compared with Canada (Garner et al., 1985), Germany (Thiel et al., 1997), Italy (Fassino et al., 2003), Japan (Tachikawa et al., 2004), Sweden (Nevonen and Broberg, 2001), and the United States (Espelage et al., 2003).

When ED patients completed EDI-2 the second and the third time after three months and six months, respectively, only Maturity Fears had decreased significantly, \(F(2,36)=5.02\). These changes were not related to the treatment outcome. The same tendency of decrease can be seen in B, BD, IE, ID, IA and IR subscales as well as the EDI-2 total score, but the difference did not reach a level of significance. These results are both qualitatively and quantitatively similar to previous Estonian data (Podar et al., 1999).

As expected, ED patients scored higher than the control group on the Neuroticism domain \(F(1,153)=42.8, p<.0001\) but lower on the Extraversion \(F(1,152)=14.7, p=.0002\). Openness \(F(1,153)=6.27, p=.013\), and Conscientiousness \(F(1,151)=9.57, p=.002\) domains.

In the patient group, the activity of MAO was slightly lower 9.76 (\(n=54\), S.D. = 2.91) than in the control group 10.79 (\(n=106\), S.D. = 3.28). ANOVA revealed that this difference was marginally significant \(F(1,158)=3.76, p=0.054\). There was a statistically significant correlation between the activity of MAO and two EDI subscales, DT (\(r=-.169, p=.036\)) and B (\(r=-.190, p=.018\)). These correlations, however, were reduced and became insignificant when the division into the patient and control group was taken into account. When controlled for smoking correlations between the activity of MAO and all EDI subscales became insignificant.

The correlations or stability in time of test–retest on EDI-2 subscale scores in eating disordered patients are shown in Table 1.

### Table 1

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Test–retest correlation</th>
<th>T1 vs T2</th>
<th>T2 vs T3</th>
<th>T1 vs T3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive for thinness (DT)</td>
<td>.73</td>
<td>.79</td>
<td>.66</td>
<td>.73</td>
<td></td>
</tr>
<tr>
<td>Bulimia (B)</td>
<td>.59</td>
<td>.63</td>
<td>.80</td>
<td>.67</td>
<td></td>
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<td>Body dissatisfaction (BD)</td>
<td>.69</td>
<td>.70</td>
<td>.71</td>
<td>.70</td>
<td></td>
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<tr>
<td>Ineffectiveness (IE)</td>
<td>.72</td>
<td>.74</td>
<td>.91</td>
<td>.79</td>
<td></td>
</tr>
<tr>
<td>Perfectionism (P)</td>
<td>.70</td>
<td>.67</td>
<td>.58</td>
<td>.65</td>
<td></td>
</tr>
<tr>
<td>Interpersonal distrust (ID)</td>
<td>.79</td>
<td>.82</td>
<td>.98</td>
<td>.86</td>
<td></td>
</tr>
<tr>
<td>Interoceptive awareness (IA)</td>
<td>.59</td>
<td>.67</td>
<td>.62</td>
<td>.63</td>
<td></td>
</tr>
<tr>
<td>Maturity fears (MF)</td>
<td>.35</td>
<td>.33</td>
<td>.70</td>
<td>.46</td>
<td></td>
</tr>
<tr>
<td>Asceticism (A)</td>
<td>.61</td>
<td>.58</td>
<td>.75</td>
<td>.65</td>
<td></td>
</tr>
<tr>
<td>Impulse regulation (IR)</td>
<td>.59</td>
<td>.57</td>
<td>.79</td>
<td>.65</td>
<td></td>
</tr>
<tr>
<td>Social Insecurity (SI)</td>
<td>.45</td>
<td>.72</td>
<td>.73</td>
<td>.63</td>
<td></td>
</tr>
<tr>
<td>EDI-2 total Score</td>
<td>.61</td>
<td>.70</td>
<td>.78</td>
<td>.70</td>
<td></td>
</tr>
<tr>
<td>MAO</td>
<td>.60</td>
<td>.55</td>
<td>.53</td>
<td>.56</td>
<td></td>
</tr>
</tbody>
</table>

Note: All correlations are significant at least \(p<.05\). T1, T2, and T3 — the first, the second, and the third time of testing.

EDI-2 stability proved to be statistically significant on all the subscales as well as in the total score. The average stability of MAO on different occasions \(r=.56\) was slightly smaller than the stability of self-reported eating disorders \(r=.70\).

### 4. Discussion

The results of this study clearly indicate that self-reported behaviors and attitudes distinguish clinical samples from a healthy control group. Both AN and BN patients scored significantly higher than normal individuals on all 11 EDI-2 subscales. The obtained profiles of eating disordered patients are very similar to those that were obtained previously in Estonian samples (Podar et al., 1999) and various other countries such as Japan, Sweden and Italy. This seems to indicate that symptoms and behaviors characterizing ED are rather universal and transcend from one culture to another. Although EDI-2 differentiated ED samples from norm rather well, it was rather insensitive to discriminate AN patients from BN patients. Like in previous reports (Nevonen and Broberg, 2001), except for the bulimia subscale the BN group did not score higher than the AN group on any EDI-2 subscales.

The current study supports previous studies that have revealed a considerable personality disposition towards ED. As expected, neuroticism was the strongest predictor of ED. Many previous studies have demonstrated that individuals who are not able to control their emotional reactions are more inclined towards ED behavior (Brewerton et al., 1993; Bollen and Wojciechowski, 2004; Brookings and Wilson, 1994; Ghaderi and Scott, 2000; Tylka and Subich, 1999). Besides neuroticism, other personality traits also join a cluster of traits that is typical to ED patients characterized besides neurotic tendencies by high introversion, closeness to experience, and low conscientiousness. It is understandable that individuals who have not learned to manage their desires (low conscientiousness), who tend to be conventional in their behavior (closeness), and who are more shy (introversion) are more prone to developing eating problems. It is an open question whether low agreeableness is also an etiological risk factor for the development of ED or not (Ghaderi and Scott, 2000). It seems, however, that AN patients have somewhat higher scores than BN patients on the agreeableness dimension (Bollen and Wojciechowski, 2004).

Like many previous studies, results of this study indicated that self-reported symptoms and problems are very stable in time despite psychological and pharmacological intervention. The average test–retest correlation of the EDI-2 total scores was .70 which is surprisingly higher than the MAO test–retest correlation \(r=.56\). It is also remarkable that the six-month stability indices were not significantly lower than the three-month stability indices.

Platelet MAO activity tended to be lower among the patients, in line with previous findings that eating disordered patients have lower than normal MAO activity (Carrasco et al., 2000; Diaz-Marsa et al., 2000a), even though these previous reports have described a considerably larger difference in platelet MAO activity between patients and healthy controls. Platelet MAO activity is considered to be individually highly stable, but indeed the studies on which this assumption is based have included...
relatively small number of subjects. In a recent longitudinal study we have found in a sample of three hundred twenty healthy participants that platelet MAO activity is stable in the large majority of subjects, but in a significant minority considerable changes occur in either direction, the test–retest correlation being 0.56 (Kiive et al., 2005). The present study demonstrates that there is a weak correlation between the central psychological symptoms of eating disorders and platelet MAO activity, but there is no clear-cut association of any of the items of EDI-2 with platelet MAO activity. The lack of correlations between personality dispositions and the MAO activity indicates that they have independent influence on eating disorders. A specific linkage with some of the items could theoretically have been expected, as both low and high platelet MAO activity have been associated with psychological deviations, the former with measures of impulsivity and the latter with anxiety symptoms (Oreland, 1993). Nevertheless, it is possible that either does EDI-2 not define these psychological dimensions which are based on the neurochemical mechanisms reflected by platelet MAO activity, or, alternatively, that specific psychological symptoms of eating disorders are associated with platelet MAO activity in a non-linear manner. Such a relationship was recently revealed in a longitudinal population-based study which suggested that both low and high platelet MAO activity predict regular smoking in adolescents, the risk factor being deviation from the population average (Harro et al., 2004), and this non-linear relationship may correspond to the complex role that serotonin and its receptor subtypes play mediating the different facets of impulsive behaviour (Evenden, 1999). For detecting such associations, however, the sample in this study is not suitable by its size and composition.

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