Neuroticism and Extraversion are modifiable by treatment in individuals at-risk for psychosis or with first-episode psychotic disorder

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ABSTRACT

Meta-analytic work suggests that Neuroticism and Extraversion levels are modifiable by treatment, but it is unknown whether this holds for individuals with subclinical or clinical psychosis. The current study aimed to examine whether 1) Neuroticism and Extraversion change through intervention in individuals at clinical high risk for psychosis (CHR) or first-episode psychosis (FEP), and 2) Acceptance and Commitment Therapy in Daily Life (ACT-DL) is more successful in this regard compared to treatment as usual (TAU). Data pertain to the INTERACT study, a randomized controlled trial on the efficacy of ACT-DL in individuals with CHR or FEP. Assessments were at baseline, 8 week post-intervention and 6 and 12-month follow-up. Our sample consisted of 142 participants (ACT-DL: 67 and TAU: 75). Mixed model analyses showed a reduction in Neuroticism at post-intervention and both follow-up. Extraversion increased at 6 month follow-up. There was no difference between ACT-DL and TAU in personality change. Analyses were controlled for clinical group status (CHR vs. FEP), gender, age, IQ, baseline personality levels and baseline symptom levels. Our findings suggest that among help-seeking people at-risk for psychosis or with first-episode psychosis, treatment may have a fast and persistent impact on particularly Neuroticism. Potential mechanisms are discussed.

1. Introduction

The premise of the developmental take on personality is that personality traits display both continuity and change, with meaningful change occurring slowly and incrementally, over a span of years rather than weeks (Roberts, Walton, & Viechtbauer, 2006). However, there is evidence suggesting that personality traits can change significantly over a short period of time, through intervention. For instance, a meta-analysis of change in Big Five personality traits through various types of interventions in several nonclinical and clinical (depressive, anxiety-, substance use-, eating-, and personality disorders) populations showed that particularly Neuroticism decreased during interventions, followed by an increase in Extraversion. Most change in the personality traits was found to occur in the first 8–10 weeks of interventions and then...
remained stable over one year follow-up (Roberts et al., 2017). A similar pattern of change in personality traits (occurring relatively fast, particularly for Neuroticism, maintained over follow-up) was found in later clinical (Zemestani, Ommati, Rezaei, & Gallagher, 2022) and nonclinical studies (Hudson, Fraley, Chopik, & Briley, 2020; Olaru et al., 2023; Stieger et al., 2021).

Yet it is unknown whether Neuroticism and Extraversion are amendable to intervention in individuals either at risk for developing a psychotic disorder or meeting formal classification criteria for a psychotic disorder. This is of potential clinical relevance. For one, high Neuroticism has been identified as a risk factor for the first onset of psychotic disorders (Goodwin, Ferguson, & Horwood, 2003; Jeronimus, Kotov, Riese, & Ormel, 2016; Krabbendam et al., 2002; Lonnqvist et al., 2009; Van Os & Jones, 2001), while high Extraversion has been found to reduce the risk (Van Os & Jones, 2001). The predis-position/vulnerability model of relations between personality and psychopathology states that personality traits may predispose individuals to develop a disorder by evoking particular responses that facilitate the development of the disorder (Andersen & Bienvenu, 2011; Krueger & Tackett, 2003). Personality traits may drive the responses to the initial subclinical psychotic experiences, as reflected in the individual’s emotional state and cognitive evaluation (Krabbendam, Myin-Germeys, Bak, & van Os, 2005). High Neuroticism is indeed found to be related to higher symptom distress and perceived threat in both nonclinical and clinical voice-hearers (So, Begemann, Gong, & Sommer, 2016). In turn, low Neuroticism, high Extraversion and high Openness were found to buffer symptom distress from beginning delusional ideation (Kuranova et al., 2020). The prospective relation between Neuroticism and psychotic disorders has been found to be robust when controlling for psychiatric history and symptom levels and hardly decays with time (Jeronimus et al., 2016). This indicates long-term stability of Neuroticism as a vulnerability marker for psychosis, in line with the vulnerability model.

Second, personality traits may influence the manifestation of psychotic disorders, even if there is no shared etiology. This potential relation between personality and psychopathology is known as the pathoplasty/exacerbation model (Andersen & Bienvenu, 2011; Krueger & Tackett, 2003). Reviews show that particularly Neuroticism and Extraversion are associated with a wide range of clinical outcomes after formal onset of a psychotic disorder; including active vs. passive coping, social and occupational functioning, quality of life, self-stigma and suicidality (Dinzeo & Docherty, 2007; Scholte-Stalenhofen, Pijnpenborg, Hasson-Ohayon, & Boyette, 2023).

Consequently, as personality traits show potential clinical relevance for both the development and the expression of psychotic disorders, the first aim of the current study was to investigate whether Neuroticism and Extraversion change through intervention in individuals at either clinical high risk for psychosis or meeting formal classification criteria for a psychotic disorder.

Personality is thought to be related to psychopathology through state (fluctuating psychiatric symptoms) and trait level (stable disposition) mechanisms. Although they are separate constructs, trait and state changes are highly correlated (Stieger, Allemand, Roberts, & Davis, 2022). The affective response to psychotic experiences is perhaps the clearest example of an area in which the constructs of personality and psychotic psychopathology overlap. Therefore, we considered a therapeutic intervention specifically aimed at reducing psychotic symptom distress. Given the growing interest in investigating whether Neuroticism and Extraversion can change through treatment in individuals at high risk for psychosis or first-episode psychosis. ACT-DL, a blended care intervention combining Acceptance and Commitment Therapy (ACT) with ecological momentary intervention in daily life, was developed for this aim (Reininghaus et al., 2019). Reininghaus et al. (2019) theorized that ACT components targeting acceptance are likely to be effective in attenuating psychotic symptom distress, while those targeting commitment may enhance reward-related motivated action and diminish persistent focus on anxiety inducing thoughts. As Neuroticism is strongly related to negative affect and stressor-related affect, as well as reduced reward sensitivity (Jacobs et al., 2011; Leger, Charles, Turiano, & Almeida, 2016), ACT may decrease Neuroticism levels. Similarly, ACT may increase Extraversion levels, given its strong relation to positive affect and activation (Smillie, De Young, & Hall, 2015) and inverse relation to stressor-related affect (Leger et al., 2016).

The INTERACT study, a multi-center randomized controlled trial, was the first to test the efficacy of ACT-DL in individuals at high risk for psychosis or first-episode psychosis. ACT-DL was compared to treatment as usual, which consisted of standard mental health care including a subgroup receiving Cognitive Behavioral Therapy for psychosis (CBT-p) (Reininghaus et al., 2019). For a detailed description of the INTERACT sample characteristics, recruitment and randomization procedure, we would like to refer to Reininghaus et al. (2019) and Myin-Germeys et al. (2022). For a description of the ACT-DL training protocol please see Vaessen et al. (2019). The main findings of the INTERACT study were that ACT-DL did not improve psychotic symptom distress, as measured with an interview, over and above treatment as usual. However, significant effects in favor of ACT-DL were found for momentary assessed psychotic symptom distress, global functioning and negative (but not positive or depressive) symptoms (Myin-Germeys et al., 2022).

Change in global functioning may also affect personality levels, as Extraversion and (inversely) Neuroticism are associated with different types of functioning in individuals with psychotic disorders (Dinzeo & Docherty, 2007; Scholte-Stalenhofen et al., 2023). Additionally, change in negative symptom levels may impact personality levels, as fluctuation in negative (and depressive but not positive) symptoms are found to be associated with changes in Neuroticism and (inversely) Extraversion in individuals with psychotic disorders (Boyette, Nederlof, Meijer, de Boer, & de Haan, 2015). The possibility that psychopathology changes personality on a trait level is known as the complication/sca model (Andersen & Bienvenu, 2011; Krueger & Tackett, 2003). Multiple models of relations between personality and psychopathology may apply.

Subsequently, the second aim of the current study is to investigate whether ACT-DL is more potent in changing Neuroticism and Extraversion in individuals at clinical high risk (CHR) or meeting formal classification criteria for a first-episode psychotic disorder (FEP), compared to treatment as usual (TAU), which may be due to either state (symptom) or trait (disposition) level mechanisms. Taken together, the hypotheses for the current study were: (1) Neuroticism will decrease and Extraversion will increase over time, in both therapy conditions (ACT-DL and TAU); (2) ACT-DL will be more successful in decreasing Neuroticism and increasing Extraversion compared to TAU. Lastly, we explored whether Neuroticism and Extraversion show a similar pattern of change through interventions in individuals with CHR and FEP, as was previously reported for various interventions in other clinical and nonclinical populations: occurring relatively fast, particularly for Neuroticism, maintained over follow-up (Hudson et al., 2020; Olaru et al., 2023; Roberts et al., 2017; Stieger et al., 2021; Zemestani et al., 2022).

2. Material and methods

2.1. Participants and procedures

Data pertain to the INTERACT study, a multicentre randomized controlled trial investigating the efficacy of Acceptance and Commitment Therapy in Daily Life (ACT-DL) in individuals at risk for psychosis and first-episode psychosis (Reininghaus et al., 2019). ACT is a third-wave Cognitive Behavioural Therapy aimed at enhancing individual’s psychological flexibility (Hayes, Clophof, Hofmann, Chin, & Safra, 2022; Hayes & Strosahl, 1999). ACT-DL was developed for enhancing the therapeutic effects of ACT under real-world conditions. For the training protocol please see Vaessen et al. (2019). Participants were...
3. Results

In the original study, 148 participants were randomized to ACT-DL + TAU (n = 71) or to TAU (n = 77 including n = 27 receiving CBTp). For the current study data on Neuroticism was available in n = 142 (ACT: n = 67 and TAU: n = 75) and for Extraversion in n = 141 (ACT: n = 68 and TAU: n = 73). Table 1 shows baseline characteristics and differences due to randomization between the two therapy conditions. No significant between-group differences were found regarding age, IQ or psychiatric symptom severity as assessed with the BPRS total score. More participants in the TAU condition were male.

3.1. Change in personality traits over time

Mixed model analyses revealed a significant overall time effect for Neuroticism (F = 6.950, p < 0.001) and Extraversion (F = 2.934, p = 0.034). In comparison to the baseline assessment, the overall level of Neuroticism was significantly decreased at post-intervention, 6-months and 12-months follow-up. Levels of Extraversion on the other hand were significantly increased from baseline to 6-months follow-up only (see Table 2).

3.2. No differential change between therapy conditions

Mixed model analyses investigating the differential effect of therapy condition on the course of personality traits revealed no overall significant time x therapy group status interaction effects for Neuroticism (F = 1.247, p = 0.293) or Extraversion (F = 0.470, p = 0.704). Table 3 shows that there was no statistically significant difference in Neuroticism and Extraversion between therapy conditions at post-intervention, 6-month and 12-months follow-up. Results did not change when individuals who received CBT-p (n = 27) were excluded from the TAU condition, in an a posteriori analysis.

4. Discussion

The current study investigated whether Neuroticism and Extraversion were affected by intervention in a help-seeking cohort of individuals at clinical high risk for first-episode psychosis or meeting formal classification criteria for a first-episode psychotic disorder. We hypothesized that in both treatment conditions (ACT-DL + TAU and TAU), Neuroticism would decrease and Extraversion would increase over time, while controlling for baseline psychiatric symptoms and other potential confounders (clinical group status, gender, age, IQ and baseline personality levels). In accordance with our hypothesis, we found an overall reduction in Neuroticism at post-intervention (8 weeks), persisting at 6 and 12-month follow-up. Extraversion increased at 6-month follow-up only. Our findings suggest that the effect of intervention on particularly Neuroticism is fast to occur and is quite longstanding (persistent to one year follow-up) in individuals with at high risk for psychosis or first-episode psychosis. This is a similar pattern of change as
involving negative affect and threat evaluation. Mason, Peters, Wilkins, and Kumari (2017) found indication that the long-term (8 year) recovery path of individuals who completed CBT for psychosis can be maintained over follow-up but, again, not more than treatment as usual, which here consisted of standard care delivered following local service guidelines. Underlying mechanism of reduced symptom distress may be such a shared mechanism. In the current INTERACT sample, ACT-DL was found to be equally effective in reducing psychotic symptom distress as treatment as usual (Myin-Germeys et al., 2022). This finding is in line with a previous longitudinal study in individuals with depressive disorders showed the impact of depressive symptom exacerbation on Neuroticism and Extraversion to be temporary (Ormel, Oldehinkel, & Vollebergh, 2004), thus indicating a potential complication effect of depression rather than (permanent) scarring.

Change in personality traits during a depressive episode has been reported to be largely driven by demoralization (Noordhof, Kamphuis, Selbom, Eigenhuis, & Bagby, 2018), which we state as the final, related (affective state) mechanism for driving change in personality levels in various treatment conditions. Frank (1961) argued that most clients seek help in a state of demoralization, i.e. generalized emotional distress, unhappiness and helplessness. Nonspecific features of psychotherapy, such as establishing the therapeutic relationship and instilling hope, are thought to be effective due to their remoralizing potential. Some authors warn that a comprehensive neurobiological theory on Neuroticism and other negative affect related traits (NART) is yet lacking (Brandt & Mueller, 2022).

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### Table 3
Mixed model interaction effects of time and therapy status on Neuroticism and Extraversion.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Time</th>
<th>TAU mean</th>
<th>SD</th>
<th>ACT-DL Mean</th>
<th>SD</th>
<th>Time x therapy interaction effect Estimatea</th>
<th>SE</th>
<th>p</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>Base</td>
<td>7.391</td>
<td>3.716</td>
<td>7.912</td>
<td>3.388</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td>6.932</td>
<td>3.785</td>
<td>6.873</td>
<td>3.301</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FU 6</td>
<td>6.542</td>
<td>4.090</td>
<td>6.501</td>
<td>3.458</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FU 12</td>
<td>5.973</td>
<td>3.552</td>
<td>6.571</td>
<td>3.587</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraversion</td>
<td>Base</td>
<td>5.473</td>
<td>3.460</td>
<td>6.192</td>
<td>3.261</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td>5.911</td>
<td>3.992</td>
<td>6.332</td>
<td>3.640</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FU 6</td>
<td>6.234</td>
<td>3.808</td>
<td>6.653</td>
<td>4.004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FU 12</td>
<td>5.563</td>
<td>3.871</td>
<td>6.720</td>
<td>3.444</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: M = mean, SD = standard deviation, SE = standard error, CI = confidence interval.

a Reference baseline and TAU.

### Table 2
Results of mixed model analyses of the effect of time on Neuroticism and Extraversion.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Time</th>
<th>M</th>
<th>SD</th>
<th>Effect of time Estimatea</th>
<th>SE</th>
<th>p</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>Base</td>
<td>7.492</td>
<td>0.181</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Post</td>
<td>6.886</td>
<td>0.206</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FU 6</td>
<td>6.452</td>
<td>0.242</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FU 12</td>
<td>6.431</td>
<td>0.242</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraversion</td>
<td>Base</td>
<td>5.729</td>
<td>0.168</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td>6.144</td>
<td>0.192</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FU 6</td>
<td>6.473</td>
<td>0.224</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>FU 12</td>
<td>6.129</td>
<td>0.226</td>
<td></td>
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</tr>
</tbody>
</table>

Abbreviations: M = mean, SD = standard deviation, SE = standard error, CI = confidence interval.

a Reference baseline.

Previously reported for various interventions in other nonclinical and clinical populations (Hudson et al., 2020; Olaru et al., 2023; Roberts et al., 2017; Stieger et al., 2021; Zemestani et al., 2022).

Our second hypothesis was that ACT-DL would be more potent in decreasing Neuroticism and in increasing Extraversion compared to treatment as usual, which here consisted of standard care delivered according to national service guidelines and protocols, including, for a subgroup, CBT for psychosis (CBTp). Our findings did not support this hypothesis, as we found no significant difference between therapy conditions; nor when excluding the CBTp subgroup in a posteriori analysis. In Roberts et al. meta-analysis (2017) in a mixed nonclinical and clinical group, the type of intervention (which included antidepres- sant therapy, cognitive behavioural therapy, psychodynamic therapy, supportive therapy and hospitalization) was only weakly associated with this reverse causation, a previous study on the stability of Big Five personality traits in psychotic disorders showed that change in depressive (and negative but not positive) symptoms were related to change in Neuroticism and (inverse) Extraversion levels (Boyette et al., 2015). A longitudinal study in individuals with depressive disorders showed the impact of depressive symptom exacerbation on Neuroticism and Extraversion to be temporary (Ormel, Oldehinkel, & Vollebergh, 2004), thus indicating a potential complication effect of depression rather than (permanent) scarring.
in demoralization and therefore labelled personality change as potentially non-descriptive, known as the state-artefact hypothesis (Ormel, Rosmalen, & Farmer, 2004). However, recent work, using a novel approach to the state-artefact hypothesis by focusing on personality traits that are considered to be free of remoralization content, showed that significant variance in personality trait change remains after controlling for change in clinical states (Stieger et al., 2022). This suggests that change in personality traits cannot fully be accounted for by change in states, i.e. a recovery from a complication effect of affective symptoms on personality (Andersen & Bienvenu, 2011; Krueger & Tackett, 2003), alone.

There are several limitations of the current study that we need to address. First, in absolute terms, the change in personality levels was small, which may translate to a modest impact in daily life expression. To what extent, and in what way, cannot be inferred from the current study, but could be examined in future momentary assessment studies. Second, we used self-reports of personality levels, which by definition is vulnerable to self-report bias. Third, the current study only examined the personality traits Neuroticism and Extraversion. The Five-Factor Model also includes the personality traits Openness, Agreeableness and Conscientiousness (Costa & McCrae, 1992) and Eysenck’s Three-Factor Model also includes Psychoticism. The current study cannot provide information on the other traits, nor on combination of traits. Fourth, because of ethical consideration, the INTERACT study contained no subgroup of individuals who did not receive any treatment at all. Consequently, it is not possible to state with certainty that the changes in personality traits are true treatment effects. However, as Neuroticism and Extraversion show general stability in individuals with psychotic disorders over a three years period (Boyette et al., 2015), changes evaluated in personality traits over a one year period is unlikely to be due to natural course. Fifth, we cannot rule out that medication use may have affected the current findings. Correction for antidepressive medication use was obsolete, as we corrected for clinical group status and antipsychotic medication use was an exclusion criterion for the high risk group. However, we cannot rule out that use of other types of medications, such as antidepressants or anxiolytics, may have impacted our findings to some degree. The publication of the main findings of the INTERACT study showed that antidepressants were used by 13–26 % of the total sample and anxioiitics by 8–31 % (Myin-Germeys et al., 2022). Finally, it is unknown whether the personality change in the individuals with psychotic phenomena represents a new level or a reset to pre-morbid levels. Meta-analysis showed that compared to healthy control subjects, individuals with psychotic disorders generally have higher mean levels of Neuroticism and lower levels of Extraversion (Ohi et al., 2016). As far as we are aware, there has been no study comparing pre- and post-onset level changes in personality in individuals with first-episode psychosis, so it is unknown to what extent first onset of psychotic disorder, often in a formative stage of life, affected the development of personality traits. If so, this would be in line with the scar model of personality and psychopathology (Andersen & Bienvenu, 2011; Krueger & Tackett, 2003).

5. Conclusion

The results of the current study suggest that personality traits are affected by intervention in individuals with high risk for psychosis or first-episode psychosis. This held especially for Neuroticism, which showed a fast and longstanding reduction, in the first 8 weeks of treatment persisting up to one year follow-up. The effect on Extraversion is found to be weaker, occur later and was found to be less persistent. Future studies should focus on mechanisms of change in the different personality traits and whether personality change improves long term clinical outcome.

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CRediT authorship contribution statement

Conceptualization: LLB and FS; Analysis: FS, EvA, TV, ABK, TB, RvW, MvdG, LdH, UR and IMG; Writing: LLB and FS; Reviewing and editing: all authors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

References


