Personality and Individual Differences 137 (2019) 1–8

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Intellect and openness differentially predict affect: Perceived and objective cognitive ability contexts

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ARTICLE INFO

Keywords:
Ability
Affect
Intellect
Mood
Openness
Intelligence
Wellbeing

ABSTRACT

The characteristics of Openness and Intellect suggest they may be differentially correlated with affect. In Study 1 (n = 224) we examined associations between Openness/Intellect and well-being. Additionally, we included variables related to ability perception: subjectively assessed intelligence and satisfaction with intelligence. In Study 2 (n = 216) we explored how Intellect/Openness predict subjective stress states related to performance of intelligence tests. Across studies, Intellect was consistently correlated with more positive affective states (mood and satisfaction), and lower stress. Openness – affect associations were inconsistent across studies, although Openness correlated with higher task-related worry and lower positive emotionality. Furthermore, in Study 1, satisfaction with one's intelligence fully mediated associations between Intellect and measures of positive affect. In Study 2, worry mediated the association between Intellect and intelligence test performance.

1. Introduction

Numerous studies have shown the importance of personality for affect and subjective well-being (DeNeve & Cooper, 1998). Among various personality traits two especially have received the most theoretical and empirical attention: Extraversion and Neuroticism. Generally, both cognitive and affective components of well-being are associated with higher Extraversion and lower Neuroticism (Diener & Lucas, 1999). Specifically, it has been found that neurotics tend to experience negative affect and tense arousal, while extraverts have a tendency towards high levels of positive affect, hedonic tone, and energetic arousal (Matthews, Deary, & Whiteman, 2009; Thayer, 1989; Watson, 2000; Zajenkowski, Goryńska, & Winiewski, 2012). These associations are not surprising given that positive and negative emotions are defining characteristics of Extraversion and Neuroticism, respectively (see Watson, 2000). Besides Extraversion and Neuroticism, other major personality traits (such as Big Five) were also studied in the context of affective functioning but these studies have been less frequent. For instance, it was found that Agreeableness predicted higher positive affect (DeNeve & Cooper, 1998) and happiness (Steel, Schmidt, & Shultz, 2008), and Conscientiousness showed a weak positive correlation with life satisfaction (Weiss, Bates, & Luciano, 2008), positive affect (Soto, 2015) and energetic arousal (Goryńska, Winiewski, & Zajenkowski, 2015). In studies conducted so far, Openness did not exhibit robust relationships with affect and well-being. In some studies Openness correlated with higher positive affect, but it did not show significant associations with negative affect (Gutierrez, Jimenez, Hernandez, & Puente, 2005; Watson, 2000). Goryńska et al. (2015) measured mood of students six times during an academic semester and found that Openness occasionally predicted high levels of energetic arousal and hedonic tone. Furthermore, Matthews et al. (1999) found that Openness was associated with lower distress in the performance context. Although some evidence exists that Openness may be related to affect, some researchers claim that Openness has more in common with cognition than with affective states (Watson, 2000). In the current investigation we challenge this view by showing that the inconsistency in previous findings might be due to differing conceptualizations of Openness.

Openness has been described variously by researchers as Culture, Openness to Experience, Intellect or Imagination (see e.g. DeYoung, 2014). Recent debate on this trait, however, revealed that Openness reflects two equally central aspects of the broader factor, which are correlated but separable. These aspects were identified as Openness and Intellect and the compound label of Openness/Intellect for the broad trait has been proposed (DeYoung, Quilty, & Peterson, 2007). To avoid confusion with similar labels of other constructs, e.g., intelligence, DeYoung et al. (2007) provided clear definitions and operationalizations of the two aspects. Intellect encompasses intellectual engagement

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https://doi.org/10.1016/j.paid.2018.08.001
Received 13 June 2018; Received in revised form 31 July 2018; Accepted 2 August 2018

with abstract and semantic information, whereas Openness reflects engagement with perceptual and aesthetic domains, artistic interest and fantasy proneness (DeYoung, Grazioplene, & Peterson, 2012). At the measurement level, Intellect contains mainly items describing perceived intelligence, e.g. *Am quick to understand things*, *Have a rich vocabulary*, and intellectual engagement, e.g. *Avoid philosophical discussions* – reversed; *Like to solve complex problems* (DeYoung et al., 2007). In contrast, the Openness scale involves items reflecting sensational experiences, e.g., *See beauty in things that others might not notice*), fantasy, e.g., *Seldom daydream*—reversed), and artistic creativity (e.g., *Believe in the importance of art* (DeYoung, 2014). Although the two aspects are inter-related, they differentially predict a number of variables. For instance, Intellect has been associated with intelligence (DeYoung, Quilty, Peterson, & Gray, 2014) as well as working memory capacity and related brain activity (DeYoung, Shamosh, Green, Braver, & Gray, 2009). Openness, on the other hand, has been linked with creativity and creative achievements in the arts (Kaufman et al., 2016). Moreover, Kaufman et al. (2010) reported a double dissociation, in which Intellect predicted working memory but not implicit learning, whereas Openness predicted implicit learning but not working memory. Furthermore, Openness and Intellect were found to differentially predict psychopathology. For instance, in one investigation Aesthetics and Feelings, the facets of the NEO PI-R that are markers of the Openness aspect, were associated with depression (Wolfenstein & Trull, 1997). Moreover, DeYoung (2014) noticed that Openness is positively related to Neuroticism and that Openness may contribute to risk for internalizing disorders by allowing a greater range of stimuli into awareness, which would lead to a greater range of stimuli in which to detect conflict or threat. Furthermore, DeYoung et al. (2012) suggested that Openness might be also close to positive schizotypy which comprises magical ideation, perceptual aberration, and overinclusive thinking. The central feature of all symptoms of positive schizotypy can be described as *apophenia*, which is the erroneous perception of patterns or causal connections (DeYoung et al., 2012). Indeed, positive schizotypy or apophenia appears to be related to Openness but not Intellect (DeYoung et al., 2012).

The contrasting theoretical conceptualizations and empirical characteristics of Openness and Intellect suggest that the two aspects of Openness/Intellect may differentially predict affect. First, although Intellect is associated with analytical and fluid reasoning (DeYoung et al., 2014) which might be regarded as 'cool' rather than 'hot' processes, there are reasons to believe that it will be significantly associated with high positive affect. Most importantly, Intellect reflects perception of one's cognitive ability and pleasant experience related to the investment of cognitive resources. Moreover, intelligence, which is primary correlated with Intellect (DeYoung et al., 2014), seems to be related to higher level of well-being, since it is modestly negatively correlated with traits related to maladjustment, including neuroticism, depression, negative emotionality, somatic symptom reporting, public self-awareness and social anxiety (see Austin, Boyle, Groth-Marnat, Matthews, et al., 2011). These findings would then suggest that Intellect is associated with greater positive mood and well-being. Additionally, a source of affective experience in high Intellect individuals might be related to the enjoyment of thinking, problem solving, and cognitive engagement.

In contrast, Openness seems to be related to negative emotionality. The findings presented above indicate that Openness correlates with depression (Wolfenstein & Trull, 1997) and Neuroticism (DeYoung et al., 2007) which are strongly related to negative mood and low level of well-being (e.g. Watson, 2000). Moreover, Openness shares some aspects with schizotypy and symptoms of schizophrenia-spectrum disorders (Chmielewski, Bagby, Markon, Ring, & Ryder, 2014; DeYoung et al., 2012) which are known be associated with negative emotionality and increased anxiety (Morrison & Wells, 2007; Ohi et al., 2016). Taking these findings into account, it might expected that Openness would be associated with negative mood and low well-being.

2. The current research

The principal aim of the research was to test the hypothesis that Intellect correlates with positive mood and well-being, whereas Openness is associated with negative mood and stress outcomes. Beyond the basic issue of the nature of bivariate relationships between Intellect/Openness aspects and affect, the literature reviewed raises three further questions that the current research also aimed to address.

Q1. What is the range of well-being variables sensitive to Intellect/Openness? Specifically, we aimed to test whether the traits are associated only with purely affective variables including mood, or whether the traits also predict cognitive aspects of well-being including higher life satisfaction, higher self-assessed intelligence, and lower worry.

Q2. What processes might mediate associations between the traits and well-being? Various processes associated with Intellect/Openness might contribute to wellbeing but mediating mechanisms were neglected in the research reviewed. Cognitive appraisal processes are central to emotional outcomes (Lazarus, 1999), so, as a first step, we investigated self-evaluations of intellectual functioning as a mediator. People who appraise their intelligence positively may experience higher well-being, whereas those who evaluate their intelligence negatively may be prone to negative affect and stress.

Q3. Do affective correlates of Intellect/Openness traits contribute to objective performance differences? Associations between Intellect and performance on tests of cognitive ability and working memory (DeYoung et al., 2009, 2014; Kaufman et al., 2010) might at least in part be a consequence of the greater well-being associated with high Intellect. We thus aimed to test whether Intellect – cognitive ability associations were mediated by affective states experienced during test performance.

Two studies were run to address these questions. Study 1 focused on testing whether Intellect and Openness differentially predict a range of wellbeing variables including both affective and cognitive factors (Q1). The study also tested for a mediating role for personal satisfaction with one's intelligence (Q2). Study 2 investigated individual differences in responses to cognitive performance, again distinguishing affective and cognitive state dimensions (Q1). It also aimed to test whether any associations between Intellect/Openness traits and test performance were mediated by individual differences in affective and cognitive state (Q3).

Specifically, in Study 1 we examined simple associations between Openness, Intellect and well-being. The latter is typically defined as 'a person's cognitive and affective evaluations of his or her life' (Diener, Lucas, & Oishi, 2002, p. 63) that is a combination of global judgement of life satisfaction and the relative frequency of experiencing positive versus negative affect (Diener, Oishi, & Lucas, 2003). Generally, we expected Intellect to be associated with higher well-being, whereas Openness should correlate with lower well-being. Furthermore, we also included additional variables related to ability perception to test their mediating role for Intellect. In particular, we were interested to what extent subjectively assessed intelligence (SAI) and satisfaction with intelligence explain well-being among individuals scoring high on Intellect.

In Study 2 we wanted to see how Intellect and Openness predict state responses in the context of intelligence test performance. We decided to use the concept developed by Matthews et al. (2002) who proposed a multi-dimensional model of subjective stress state related to cognitive performance, including cognitive and motivational constructs in addition to affective dimensions. The general prediction was that Intellect would be associated with more pleasant experiences and higher motivation in the context of cognitive performance, whereas Openness would be related to more stressful experiences.

3. Method

The research was approved by the ethics committee of Faculty of Psychology at University of Warsaw. Verbal informed consent was

obtained from all participants after careful information about the general aim of each study, the study procedure and protocol clearly mentioning the possibility to withdraw from participating in the study.

All data were uploaded to Open Science Framework and are available under the following address: osf.io/sk546.

3.1. Study 1

In Study 1 we examined associations between Openness, Intellect and various measures of well-being. As was already noticed, psychological well-being is regarded as a combination of cognitive and affective evaluations of life (Diener et al., 2003); thus, both aspects were included in the present study. Specifically, we used a widely known measure of life satisfaction (Diener, Larsen, & Griffin, 1985) to assess the cognitive aspect of well-being. For affect we referred to two popular conceptualizations of mood. First, we included the three-factor model of mood by Matthews et al. (1990), which expands the two factor model comprising tense arousal and energetic arousal proposed by Thayer (1989). The model distinguishes between three bipolar dimensions: tense arousal (contrasting tension and nervousness with relaxation and calmness, energetic arousal (vigour and energy vs. fatigue and tiredness), and hedonic tone (contrasting pleasantness with unpleasantness). The second mood conceptualization was the one by Watson (2000) who proposed two broad dimensions: positive affect which encompass a wide range of positive emotional experiences, and negative affect, reflecting negative states, including sadness, anxiety and hostility. We expected that Intellect would be associated with higher life satisfaction and positive mood, that is high levels of energetic arousal, hedonic tone and positive affect, and low levels of tense arousal, and negative affect. In the case of Openness, we expected a reversed pattern of relations.

Additionally we sought for variables that may play a mediational role explaining the relationship between Intellect and affective functioning. In particular, we were interested in subjectively assessed intelligence (SAI) and satisfaction with intelligence. Although SAI has been widely studied in psychological research (see Chamorro-Premuzic & Furnham, 2004), satisfaction with intelligence is a new construct which we propose in the current study. The latter reflects domain-specific satisfaction, similar to aspects assessed in the 'bottom-up' models which assesses responses to a variety of domain-specific items, e.g. satisfaction with work, health, family, relationship (see Boyle, Helmes, Matthews, & Izard, 2015).

3.1.1. Participants

The study was completed by 224 (156 female, 68 male) volunteer participants, who were recruited via publicly accessible social networking websites. Their mean age was 23 years (SD = 5.96). Participants were asked to fill in a set of questionnaires. All subjects gave their informed consent for the release of their test scores for research purposes, and all were offered feedback on general results of the study.

3.1.2. Measures

Openness and Intellect were assessed with *International Personality Item Pool - Big Five Aspect Scale* (BFAS; DeYoung et al., 2007) in the Polish adaptation (Strus, Cieciuch, & Rowiński, 2014). Each scale consists of 10 items. Participants are asked to rate how much the statements are related to them on the five - point Likert-type scale, from 1 (*strongly disagree*) to 5 (*strongly agree*). The reliability and validity of the Polish version was tested on a large sample, showing high internal consistency, adequate factor structure and correlations with the scales from other Big Five measures (Strus et al., 2014).

Life satisfaction was measured with Polish version of *Satisfaction With Life Scale* (SWLS: Diener et al., 1985; adapted by Jankowski, 2015). The scale is widely used to measure subjective life satisfaction as a component of well-being. It consists of five items, for example "I am satisfied with my life" or "The conditions of my life are excellent". Participants give their answers on 7-point Likert-type scale ranging from 1 = *I totally disagree* to 7 = *I fully agree*.

Mood was assessed with two widely used scales. Positive and negative affect were measured with the Polish version of *Positive and Negative Affect Scale* (PANAS; Watson, Clark & Tellegen, 1988; adapted by Brzozowski, 2010). It consists of 20 adjectives reflecting different emotional states: 10 positive and 10 negative – these items create two subscales: positive and negative affect. Participants rated how much they experienced each particular state, using a 5-point Likert scale ranging from 1 = *not at all or very slightly* to 5 = *extremely*. The subscales have high reliability (αs ranging from 0.73 to 0.95 across studies) and good factor structure and validity (Brzozowski, 2010). Additionally, the Polish translation of *UWIST Mood Adjective Check List* (UMACL) was used (Matthews et al. 1990). The scale has 24 items divided into three subscales measuring: energetic arousal (EA; with poles: energetic-tired); tense arousal (TA; nervous-relaxed), and hedonic tone (HT; pleasant-unpleasant). Internal consistency for each subscale is high (Cronbach's alphas range from 0.71 to 0.90).

Subjectively Assessed Intelligence (SAI). Participants assessed their own intelligence on a 1–10 point rating scale ranging from very low (1) to very high (10). Participants' SAI was indexed with the marked column counting from the first to the left; thus the score ranged from 1 to 25 (see Zajenkowski, Stolarski, Maciantowicz, Malesza, & Witowska, 2016 and Zajenkowski & Gignac, 2018 for more details). Prior to providing a response to the scale, the following instruction was presented:

> "People differ with respect to their intelligence and can have a low, average or high level. Using the following scale, please indicate where you can be placed comparing to other people. Please mark an X in the appropriate box corresponding to your level of intelligence."

Satisfaction with Intelligence Scale was created on the basis of *Satisfaction With Life Scale* (Diener, Larsen, & Griffin, 1985). It consists of five items, similar to SWLS but instead of general life satisfaction it asks about satisfaction with one's abilities, for example "I am satisfied with my intelligence" or "In most ways my intelligence is close to my ideal.". Participants give their answers on 7-point Likert-type scale ranging from 1 = *I totally disagree* to 7 = *I fully agree*. We conducted an exploratory factor analysis to evaluate the factor structure of the instrument. The inter-item correlation associated with the 5 items ranged from 0.62 to 0.85. The Kaiser-Meyer-Olkin measure of sampling adequacy was estimated at 0.85, which suggested the data were appropriate for data reduction (Kaiser & Rice, 1974). The parallel analysis suggested the presence of one large factor explaining over 76% of the variance. The single-factor model solution was defined by loadings exceeding 0.81. The internal consistency of the entire scale was estimated via coefficient α at 0.92.

3.1.3. Results

In Table 1 we present correlations and descriptive statistics of all variables from study 1. The results indicated that Intellect was essentially related positively to all indicators of well-being. Specifically, it was associated with higher levels of life satisfaction and positive mood (positive affect, energetic arousal, hedonic tone) and lower level of negative mood (negative affect and tense arousal). Moreover, Intellect was strongly associated with intelligence satisfaction and subjectively assessed intelligence. In contrast, Openness did not show significant correlation with affect, except for a negative relationship with energetic arousal. Finally, both SAI and intelligence satisfaction correlated with high well-being (mood and life satisfaction) in a similar way to Intellect.

Next, regressions were run to test the independent contributions of Intellect and Openness to the indicators of well-being and SAI (Table 2). The analyses indicated that Intellect was associated with higher positive mood, satisfaction and SAI, and lower negative mood, whereas Openness, was a significant (and negative) predictor of positive affect,

Table 1
Correlations of all variables from study 1.

	1	2	3	4	5	6	7	8	9	10
1. Intellect	–									
2. Openness	0.243**									
3. Life satisfaction	0.270**	−0.005								
4. Positive affect	0.209**	−0.098	0.455**							
5. Negative affect	−0.306**	0.011	−0.286**	−0.064						
6. Energetic arousal	0.229**	−0.217**	0.466**	0.734**	−0.284**					
7. Tense arousal	−0.266**	−0.108	−0.189**	−0.082	0.604**	−0.064				
8. Hedonic tone	0.255**	−0.090	0.542**	0.552**	−0.591**	0.659**	−0.451**			
9. Intelligence satisfaction	0.618**	0.069	0.545**	0.318**	−0.211**	0.211**	−0.250**	0.357**		
10. Subjective intelligence	0.468**	−0.069	0.274**	0.212**	−0.163*	0.198**	−0.133*	0.229**	0.562**	–
M	37.44	37.31	21.13	27.75	20.14	19.92	15.80	22.63	23.60	7.30
SD	6.50	7.25	7.14	8.27	7.92	5.06	4.03	5.34	6.74	1.22
A	0.82	0.82	0.90	0.90	0.90	0.83	0.74	0.91	0.92	–

* $p < 0.05$.
** $p < 0.01$.

energetic arousal, hedonic tone and SAI.

Subsequently, we decided to test mediation models examining to what extent the perception of one's cognitive ability (SAI, intelligence satisfaction) explains the relationship between Intellect and affect, addressing the second research question above. We used the PROCESS macro by Hayes (2015) which tests for indirect effects by calculating (bootstrapping) confidence intervals for indirect effects. In each analysis Intellect was the independent variable, while affect and life satisfaction served as dependent variables. We tested two mediators separately: intelligence satisfaction and subjectively assessed intelligence. The mediation analyses with intelligence satisfaction (see Fig. 1) revealed that the total effect between Intellect and positive affect, hedonic tone and life satisfaction were reduced upon the inclusion of the mediator, indirect effects were 0.19, $p < 0$ 0.05; 95%CI = 0.09/0.31; 0.19, $p < 0$ 0.05; 95%CI = 0.10/0.29, and 0.38, $p < 0$ 0.05; 95%CI = 0.27/0.48, respectively. Thus, there was full mediation in these cases. Models with other mood dimensions were not significant. Furthermore, we found that subjectively assessed intelligence was significant mediator only in one model (Fig. 2). Specifically, it partially mediated the Intellect – life satisfaction relationship (indirect effect 0.10, $p < 0.05$; 95%CI = 0.03/0.17.

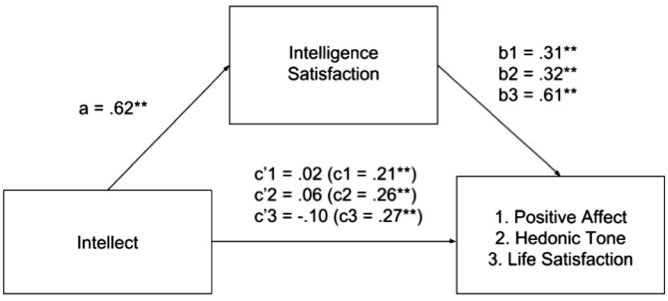

Fig. 1. Results of the mediation analysis from Study 1: the effect of Intellect on Positive Affect, Hedonic Tone and Life Satisfaction and Intelligence Satisfaction as a mediator. (**$p < 0.01$. *$p < 0.05$). Intellect was assessed with the Big Five Aspects Scale; Positive Affect is a subscale from Positive Affect Negative Affect Scale; Hedonic Tone is a subscale from the UWIST Mood Adjective Checklist; Life Satisfaction was assessed with Satisfaction With Life Scale; Intelligence Satisfaction was measured with Satisfaction With Intelligence Scale.

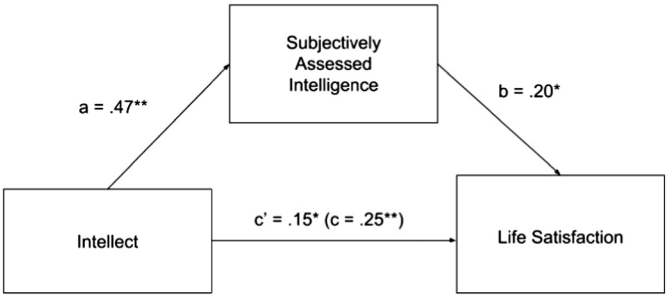

Fig. 2. Results of the mediation analysis from Study 1: the effect of Intellect on life satisfaction and subjectively assessed intelligence as a mediator. (**$p < 0.01$. *$p < 0.05$). Intellect was assessed with the Big Five Aspects Scale; Life Satisfaction was assessed with Satisfaction With Life Scale.

3.2. Study 2

In Study 2 we examined how Intellect and Openness are associated with state responses related to intelligence tests performance. We referred to a model of stress state related to cognitive performance proposed by Matthews et al. (2002) who identified three broad factors: task engagement which integrates state constructs that relate to task interest and focus: energetic arousal, motivation and concentration, distress integrating unpleasant mood and tension with lack of confidence and perceived control, and worry, a cognitive factor primarily composed of self-focused attention, low self-esteem and cognitive interference. The model recognizes that task performance environments not only influence mood but also motivational and cognitive elements of subjective

Table 2
Regressions of well-being on intellect and openness.

	Life satisfaction		Positive affect		Negative affect		Energetic arousal		Tense arousal		Hedonic tone		Intelligence satisfaction		Subjective intelligence	
	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2
Intellect	0.29**	0.08**	0.25**	0.06**	−0.33**	0.10**	0.30**	0.08**	−0.26**	0.06**	0.30**	0.08**	0.64**	0.39**	0.51**	0.25**
Openness	−0.08	0.01	−0.16*	0.02*	0.09	0.01	−0.29**	0.08**	−0.05	0.00	−0.16*	0.03*	−0.09	0.01	−0.18**	0.03*

ΔR^2 = incremental R for each predictor when entered after the other predictor.
* $p < 0.05$.
** $p < 0.01$.

Table 3
Correlations of all variables from study 2.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Intellect	–											
2. Openness	0.192**											
3. Task engagement pre	0.195**	0.049										
4. Distress pre	−0.348**	0.058	−0.508**									
5. Worry pre	−0.224**	0.056	−0.069	0.335**								
6. Task engagement post	0.174*	−0.022	0.639**	−0.322**	−0.035							
7. Distress Post	−0.246**	0.099	−0.218**	0.486**	0.225**	−0.378**						
8. Worry post	−0.300**	0.152*	−0.116	0.359**	0.632**	−0.126*	0.300**					
9. Numbers	0.112	0.048	−0.031	−0.078	−0.099	0.020	−0.062	−0.191**				
10. Paper folding	0.121	0.100	−0.032	−0.005	−0.131*	0.054	−0.020	−0.112	0.403**			
11. Cattell	0.095	0.038	−0.077	0.031	−0.114	−0.041	−0.017	−0.056	0.411**	0.463**		
12. *gf*	0.140*	0.080	−0.061	−0.022	−0.149*	0.014	−0.043	−0.155*	0.761**	0.795**	0.799**	–
M	32.23	33.94	21.71	10.30	15.40	19.52	13.82	10.69	11.18	10.10	25.86	0.00
SD	6.37	6.79	5.06	5.43	6.78	5.73	5.70	6.05	3.07	3.38	4.31	1.00
α	0.70	0.68	0.74	0.80	0.83	0.80	0.79	0.78	0.81	0.84	0.80	

* $p < 0.05$.
** $p < 0.01$.

state, so that a broader-based assessment than mood alone is required. This model has been validated in performance studies in which different stressors elicit different patterns of response across the multiple dimensions (Matthews, 2016), and in correlational studies demonstrating that the dimensions are associated with different patterns of appraisal, coping, workload, and performance (Matthews et al., 2002). Because intellectual engagement and enjoyment of thinking are key characteristics of Intellect (e.g. DeYoung, 2014), we expected that individuals scoring high on this scale would feel low distress and worry along with high task engagement while solving an IQ test. By contrast, we expected that those scoring high on Openness would experience more distress and worry, because of their general predisposition to negative emotionality and fantasy proneness (DeYoung et al., 2012). In the case of task engagement, however, it is difficult to predict the specific direction of its association with Openness.

3.2.1. Participants

A total of 216 (112 female, 104 male) participants took part in the study. They were recruited via publicly accessible social networking websites. Their mean age was 22.90 years ($SD = 4.70$). The sample was composed of undergraduate students from various universities in Warsaw. Participants were asked to fill in a set of questionnaires and cognitive tests. They were tested individually in a quiet lab at the University of [blind]. All subjects gave their informed consent for the release of their test scores for research purposes, and all were offered feedback on general results of the study.

3.2.2. Measures

Openness and Intellect were measured with the same scale as in study 1.

Stress states were measured with the *Dundee Stress State Questionnaire* (DSSQ; Matthews et al., 2002) in the short version (cf. Matthews & Zeidner, 2012), translated into Polish (see Zajenkowski et al., 2016). The DSSQ measures three factors: task engagement, distress and worry. On the instrument, there are 24 items with 5-point response scales. The internal consistency of the Polish version is high (task engagement $\alpha = 0.80$; distress $\alpha = 0.76$; worry $\alpha = 0.84$) and its validity has been evaluated in several studies (e.g. Zajenkowski et al., 2016; Zajenkowski & Zajenkowska, 2015). The DSSQ was administered twice: just before and after intelligence tests. Instructions for the post-task version ask respondents to report their subjective states during task performance.

Fluid intelligence was assessed with three tests. For the *Number Series Test* (NST), the task was to find the hidden rule, according to which a sequence or an array of numbers was constructed, and to complete the sequence or the array with the missing number. For example, the sequence "1, 5, 12, 22, 35, …" should be completed with "51". Participants were given 18 min to solve 18 number series problems with progressive increase in difficulty. The second fluid intelligence test was *Cattell's Culture Fair Intelligence Test* (CFT; Cattell, 1973) which consists of four nonverbal subtests with strict time limits. The first part, *Series*, consists of 13 items each comprising a series of 3 abstract shapes/figures with one piece missing. Respondents must complete the series by selecting the single correct answer from six options. In the subtest *Classifications* respondents are required to identify the two patterns from a set of five which do not belong to the group; there are 14 set of patterns. The *Matrices* subtest is similar to the Raven test: only one of six choices fits the blank the blank space in each of 13 matrices. The *Conditions* subtest (10 items) requires the respondent to select one out of five answers in order to replicate the relationships between figures and dot in the model. The total number of correct answers across all subtests constituted the CFT final score. The last test was *Paper Folding Test.* The test consisted of 16 tasks and the time limit was 10 min. In each task participants were presented with a drawing showing a sheet of paper which has been folded. The black dot showed where a hole was punched. The task was to choose one correct answer out of five drawings presenting the holes when the sheet was unfolded. In the analyses described below we used factor score of all three fluid intelligence tests.

3.2.3. Results

In Table 3 we present correlations and descriptive statistics of all variables. The results indicated that Intellect was generally associated with lower stress (low distress and worry and high task engagement) before and after intelligence tests. Openness did not exhibit significant associations with stress states except for worry in a post task measurement. Interestingly, the latter correlation indicated that individuals high on Openness tended to have more task irrelevant thoughts during performance. Finally fluid intelligence (factor score, *gf*) was positively correlated with Intellect and negatively with pre and post task worry.

In order to test how the level of stress changed in all participants while taking the intelligence tests, within-subjects *t*-tests were performed. The analyses indicated that task engagement and worry decreased ($t = 2.20$; $p < 0.001$, $t = -3.53$, $p < 0.001$, respectively; see Table 2 for means and SDs) whereas distress increased ($t = 4.76$, $p < 0.001$), which is typical for performance of cognitively demanding tasks (Matthews et al., 2002).

Subsequently, we decided to examine whether Intellect predicts the second measurement of stress states controlling for the pre-task (baseline) level of stress. It is believed that the post-task score is more representative of the state during task performance, whereas the pre-task score represents general dispositions and anticipation of the task (e.g.,

Table 4
Intellect and pre task stress states as predictors of post task stress states.

Outcome: task engagement post task		Outcome: distress post task		Outcome: worry post task	
Predictor	B	Predictor	β	Predictor	B
Task engagement pre task	0.64**	Distress pre task	0.47**	Worry pre task	0.59**
Intellect	0.06*	Intellect	−0.10	Intellect	−0.20**
Openness	−0.06	Openness	0.09	Openness	0.16**

* $p < 0.05$.
** $p < 0.001$.

Matthews & Zeidner, 2012). This analysis tested whether Intellect is uniquely associated with the full range of task-induced stress responses, or with only a subset of DSSQ dimensions, relevant to the first research question (Q1) defined previously. Table 4 presents the results of three regression models, one for each DSSQ scale. The analysis controlled for pre-task state, and Openness, similarly to study 1. The analyses revealed that in the case of task engagement and distress, the first, pre-task measurement was a significant predictor of the second assessment of these stress states, while Intellect and Openness did not predict significantly post-task levels of task engagement and distress. Additionally, Intellect, Openness and first measurement of worry were significant predictors of post-task worry. Specifically, worry was negatively related to Intellect and positively to Openness.

Finally, because Intellect, intelligence and worry were intercorrelated, we tested a mediation analysis. Specifically, we were interested whether worry (post-task) mediated the relationship between Intellect and performance on fluid intelligence tests (Fig. 3). This analysis addressed Q3, by testing whether higher test scores in those high in Intellect could be attributed to lower worry. We found that the total effect between Intellect and *gf* was reduced upon the inclusion of worry; the indirect effect was 0.046, $p < 0$ 0.05; 95% CI = 0.01/0.10.

4. Discussion

Findings from two studies confirm the importance of DeYoung et al.'s (2007) distinction between Openness and Intellect aspects for understanding the affective correlates of the broader Openness/Intellect factor. Across both studies, Intellect was consistently correlated with more positive affective states, including multiple dimensions of mood and satisfaction (Study 1), and the broader state dimensions assessed by the DSSQ (Study 2). By contrast, Openness – affect associations were weak and inconsistent across studies, although Openness was associated with lower energetic arousal in Study 1 and higher post-task worry in Study 2. Moreover, after controlling for Intellect, Openness was associated with lower positive affect and hedonic tone. The answer to the first research question posed previously (Q1) is that the two aspects are differentially associated with a range of well-being outcomes, including both affective and cognitive scales. Studies also identified mediating pathways for associations between Intellect and outcome variables. In Study 1, satisfaction with one's intelligence fully mediated associations between Intellect and several measures of positive affect, suggesting a cognitive mechanism for mediation (Q2). In Study 2, worry mediated the association between Intellect and objective intelligence test performance, showing that performance enhancements associated with Intellect may be attributable to cognitive components of subjective state (Q3).

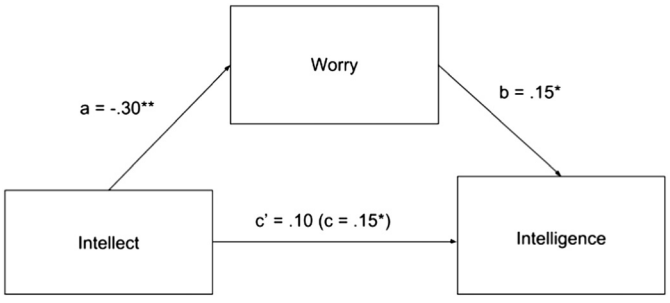

Fig. 3. Results of the mediation analysis from Study 2: the effect of Intellect on intelligence test performance and worry as a mediator. (**$p < 0.01$. *$p < 0.05$).). Intellect was assessed with the Big Five Aspects Scale; Worry is a subscale of Dundee Stress States Questionnaire; Intelligence is a factor score from three tests: Cattell's, Paper Folding and Number Series.

In the remainder of this discussion, we discuss two general issues raised by these findings. First, we consider mechanisms for the differing affective outcomes of the two aspects of Openness/Intellect. Second, we address possible explanations for associations between Intellect, objective performance and worry. We also outline limitations and directions for further research.

Intellect was significantly correlated with all the affective variables in both studies, with *r*s ranging from 0.17 (Study 2, post-task engagement) to −0.35 (Study 2, pre-task distress). One explanation is that Intellect acts as a proxy for cognitive ability, which is modestly negatively related to a range of variables associated with maladjustment (Austin et al., 2010). In the present data, however, g_f was, in Study 2, a weaker predictor of subjective states than Intellect, correlating significantly only with lower worry. Previous studies utilizing the DSSQ have shown modest significant correlations between g_f and lower distress (Matthews et al., 2015; Shaw et al., 2010), lower worry (Matthews, Warm, Shaw, & Finomore, 2014) and higher task engagement (Zajenkowski et al., 2016). Such findings are consistent with the view that higher intelligence confers some general mental and physical adaptive capacity (Luciano, Weiss, Gale, & Deary, 2017). However, the hypothesis that greater wellbeing is intrinsic to cognitive ability does not explain the affective correlates of Intellect here.

Study 1 confirmed that Intellect was associated with self-assessed intelligence, but showed that the trait was even more strongly associated with satisfaction about one's intelligence. That is, Intellect does not just represent a dispassionate rating of cognitive competency, but an affectively-loaded attitude towards personal intellectual functioning. Indeed, satisfaction with intelligence mediated associations between Intellect, and positive affect, hedonic tone and life satisfaction. These outcomes include both moods such as positive affect, and life satisfaction which is more cognitive in nature (Diener et al., 2003). Interestingly, satisfaction with intelligence mediated positive rather negative aspects of well-being which may suggest that satisfaction with one's ability increases positive emotionality but do not play a role in the reduction of negative affect among individuals high on Intellect.

It is striking that Intellect was correlated with affect even in Study 1, in which there was no requirement to perform an intellectual task. At least in Western cultures, intellect may be of sufficient importance to the self-schema that it influences general emotional functioning. This hypothesis predicts that the Intellect – affect association should be moderated by factors that influence self-regulation. For example, the association might disappear or turn negative if we induced failure on an intellectual task, which might be more threatening or disappointing to the high-Intellect person.

The weaker trend towards associations between Openness and negative states is consistent with its association with maladaptive elements of personality, including negative affectivity (DeYoung, 2014). The contrast between Openness and Intellect as predictors of subjective state was evident in both studies, in which the two aspects showed opposite correlations with energetic arousal, positive affect, hedonic tone and post-task worry. The latter results seem to be especially interesting, given that Openness was not associated with objective test score, so elevated worry cannot be attributed to realistic concerns about performance. Instead, the worry response may be linked to the possible association between Openness and schizotypy noted by DeYoung et al.

(2012). Shaw et al. (2010) identified a factor of heightened mental experience defined by traits including aspects of schizotypy, sensation seeking and low internal boredom. This factor correlated positively with Openness/Intellect and with worry experienced during a vigilance task. In other words, Openness may promote a vivid interior mental life that is expressed as self-focused intrusive thoughts and daydreams (i.e., worry) under the mildly stressful circumstances of an intelligence test. We would expect that Openness might be related to more positive mental states under circumstances that might promote enjoyable creative thinking or fantasy, such as viewing imaginative art or a science-fiction movie.

Study 2 further differentiated the two aspects by showing that only Intellect was associated with objective ability test performance, consistent with previous findings (DeYoung et al., 2014; Kaufman et al., 2010; Smillie, Varsavsky, Avery, & Perry, 2016). One explanation is that higher ability is intrinsic to higher Intellect. Studies of the broader five factor model (FFM) Openness trait suggest that it promotes acquisition of cognitive skills over the lifespan, although this investment process influences crystallized ability more strongly than fluid ability (Von Stumm & Ackerman, 2013). There is also evidence from longitudinal data for childhood ability predicting FFM Openness in middle-aged adulthood, suggesting a reciprocal relationship (Furnham & Cheng, 2016).

However, the involvement of worry suggests that there may be more to the present findings than a stable, intrinsic relationship between Intellect and ability, i.e., Intellect may influence temporary performance as well as enduring competence. Intellect predicted post-task worry even with pre-task worry controlled, implying that it influences the person's immediate response to performing the task. Furthermore, the worry response (i.e., worry measured post-task) mediated the Intellect – task performance association, consistent with the direct impacts of worry states on intellectual performance demonstrated in test anxiety research (Zeidner & Matthews, 2005). On the basis of a meta-analysis, Moran (2016) concluded that worry may impact performance both via anxiety (impairing domain-general attention), and via direct impairment of phonological storage.

Moran's (2016) analysis might also help to explain why the association between Intellect and g_f, though significant, was of smaller magnitude than the Openness/Intellect-ability correlations sometimes reported. Impairment of phonological storage would influence verbal tasks more than nonverbal tasks, and the current ability tasks required relatively little verbal representation, which may have made them insensitive to worry. Against this interpretation, DeYoung et al. (2014) found that Intellect was similarly associated with performance on both verbal and nonverbal tasks. However, their study did not test for a mediating role of worry. The influence of Intellect on competence and performance may play out somewhat differently depending on the exact tasks used, and the context for testing.

Another possible interpretation is that the role of worry reflects the impact of task motivation and engagement in reducing worry, especially off-task thoughts, rather than a direct causal impact of worry. Such an argument would be in line with Smillie et al.'s (2016) proposal that Intellect promotes greater allocation of processing resources rather than greater resource availability. It is also consistent with the positive association found between task engagement and Intellect. On the other hand, while higher task engagement has been found to correlate with performance on a fluid intelligence test, as well as a range of attentionally demanding tasks (Matthews et al., 2014), this was not the case here. We can tentatively assign a stronger causal role to worry, although further studies would be necessary to develop a causal argument.

Our research entails also some general observations about personality traits and their associations with outcome variables. Mõttus (2016) suggested that causal interpretations of the links between personality traits and various types of outcomes require the associations to be independent of specific ways of operationalizing the traits. This requires, among other things, that lower-level facets or even items of a trait should correlate similarly with outcomes to support causal unity of the higher-level trait. Tests of this kind have been made with respect to some traits. For instance, Lucas, Diener, Grob, Suh, and Shao (2000) found that extraversion facets are linked by reward sensitivity. Although sociability was an important part of extraversion, Lucas et al. (2000) suggested that it does not constitute the core feature of extraversion, but is rather a by-product of reward sensitivity. In this vein, our findings would suggest that positive affective experience found among individuals with high Intellect at the aspect level is not a key characteristic of the higher order Openness/Intellect trait. Nevertheless, the two aspects may each have their own more fine-grained causal unity as defined by Mõttus (2016), although further work comparing multiple indicators of each aspect would be required to test this possibility. The current research has several limitations. First, we examined the differential roles of Openness and Intellect in predicting affect only in the context of intelligence test performance (Study 2) and ability related measures (Study 1). However, this procedure may be more revealing about affect in Intellect rather than Openness. As mentioned above, individuals scoring high on Openness might be emotionally sensitive to other contexts, related for instance to creativity or sensual experiences. Thus, future studies might explore affective response in Openness/Intellect in various situations, either through experimental studies or experience-sampling in everyday life. Second, the study was not designed to investigate how associations between Openness aspects and affect might be dependent on person × situation interactions, such as the extent to which the environment allows people to choose situations congruent with their personality. People high in Openness might be happy when they have opportunities for a rich cultural life, and people high in Intellect might be unhappy if prevented from using their intelligence. For example, Matthews and Falconer (2002) found that customer service agents high in Intellect/Openness showed lower task engagement during a work simulation that required them to produce scripted responses to inquiries, a task requiring little independent thought or creativity. Third, in study 1 we did not include objectively measured intelligence. This could be helpful in establishing to what extent individuals with high Intellect realistically perceive their cognitive abilities. It has been shown that overestimation of one's intelligence positively influences well-being (Dufner et al., 2012). Fourth, studies used convenience samples of relatively small sizes. The roles of Intellect and Openness in well-being may vary across different levels of cognitive ability, educational level, and occupational status. For example, high Intellect may be more socially advantageous among the “cognitive elite” than in occupations requiring little intellectual thought or formal education. Thus, larger and more systematic sampling would be necessary to address such questions.

Acknowledgment

Preparation of this manuscript was supported by Grant no 2016/23/B/HS6/00312 from National Science Centre in Poland.

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