Negative Cognitions in the Personality Domains of the AMPD

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Abstract

Healthy individuals show a tendency towards positive cognitions that is reversed during depression. This tendency is revealed by the Scrambled Sentences Task (SST), an experimental procedure that was also shown to be associated with vulnerability to suffer from depressive episodes. Here, we used the SST to map the prevalence of negative cognitions across the personality domains of criterion B of the Alternative Model of Personality Disorder (AMPD) of the DSM-5 in healthy individuals. The AMPD was developed to characterize personality in a dimensional approach spanning both healthy and pathological individuals. We expected negative cognitions to be more frequent among individuals with high negative affectivity and detachment scores, as these dimensions are thought to be associated with disorders of affect. This association was stable and significant in three separate experiments and persisted for detachment after adjusting for current depression levels. In the Five-Factor Model of Personality (FFM), in contrast, only openness failed to show any association with negative cognitions. Negative affectivity and detachment differed in the preferential association with negative and positive cognitions, respectively. This finding suggests a possible role of motivational factors related to sensitivity to negative and positive incentives in linking personality dimensions and cognitive tendencies, with an anhedonic dimension of negative cognitions being present alongside current depressive symptoms.

Introduction

The boundary between healthy functioning and mental illness categories is being revised by the adoption of dimensional approaches to psychopathology. In this view, most of the symptoms of mental disorders are on a continuum of normal personality traits, and those symptoms that occur together should be characterized in terms of a covariance structure in these traits (DeYoung & Krueger, 2018; Skodol et al., 2011), rather than through arbitrary boundaries between artificial disease categories. These approaches are particularly important in the revised classifications of personality disorders (AMPD in DSM-5, ICD-11), but analogous efforts involve psychopathology as a whole (HiTOP, Kotov et al., 2017).

One aspect of the continuum between healthy mental functioning and psychopathology is the connotation of thoughts and beliefs that arise spontaneously or in response to external stimuli

or events. On an everyday basis, healthy individuals show optimistic tendencies when thinking about past success and future opportunities, i.e. a positive bias in everyday cognition ('positive illusions', Taylor & Brown, 1988). The optimistic tendency of these cognitions in the healthy is reversed in clinical conditions such as depression (Beck, 1979). Hence, exploring the existence of this tendency within dimensional classifications opens a window on the relationship between dimensional models of psychopathology and cognitions that are of relevance in a clinical perspective.

The Scrambled Sentences Task (Wenzlaff & Bates, 1998) is an empirical procedure developed in the 1990s to test the hypothesis that the activity of depressive schemata plays a key role in the development of depressive episodes (Hedlund & Rude, 1995; Rude et al., 2002; Wenzlaff & Wegner, 2000). Participants are presented with a set of words in random order, with the task of assembling them into a sentence. The set is compatible with two alternative sentences, and the chosen sentence is statistically associated with the cognitive propensity of the individual. An example is shown in Figure 1.

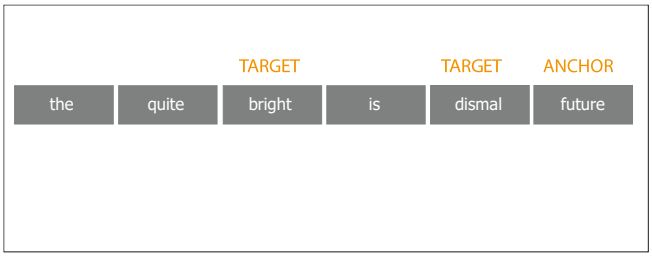

Figure 1. Exemplary structure of an SST sentence with one positive and one negative target word ('the future is quite bright/dismal'). 'Targets' are words that may occur in the final position of a syntactically valid sentence (the labels in color are not shown during the test; they explain the terminology in the figure). Participants are asked to form a syntactically correct sentence and click on the word that occurs last in that sentence. Selection of non-targets is scored as an error.

SST scores have been shown to predict the future occurrence of depressive episodes and identify vulnerable individuals (Rude et al., 2002), suggesting that they may provide information on a personal trait beyond current depressive symptom levels. SST scores are also robustly associated with subclinical depressiveness as assessed by epidemiological scales in healthy individuals (Rude et al., 2002; Viviani et al., 2010), thus providing evidence of the propensity toward optimistic cognitions that characterizes healthy and subclinical functioning (Viviani et al., 2010; Viviani, 2013; for a systematic review and meta-analysis, see Würtz et al., 2022).

We will here explore the propensity for negative cognitions, as elicited by the SST, in the recently introduced trait-domains of the 'Alternative Mode of Personality Disorders criterion B' (AMPD) of the DSM-5 (American Psychiatric Association, APA 2013) assessed by the associated Personality Inventory for DSM-5 (PID-5, APA, 2013). In a dimensional system, the scores of the individual scales that span symptom space are not meant to constitute alternative categorical nosological entities. Instead, psychopathology is characterized by a position in this space that may involve multiple scores simultaneously. In the case of depression, it has been argued that any valid assessment of this condition should be associated with higher loadings on the two PID-5 domains *negative affectivity* and *detachment* (Krueger & Markon, 2014), both of which are associated with neuroticism and extraversion in the Five-Factor Model (FFM). In this dimensional classification, conditions in the depressive spectrum may be associated with a location in the subspace spanned by these two PID-5 domain dimensions (to which we will refer here as the *internalization subspace*). Negative affectivity

scores may reflect the documented relationship between depression and negative life events (Brown et al., 1987; Heim et al., 2008; Swartz et al., 2015), i.e. the enhanced reactivity to negative environmental interactions in individuals with high neuroticism scores (Kendler & Prescott, 2006). Detachment is thought to reflect the diminished receptivity to appetitive incentives provided by the environment, which motivate efforts to attain hedonic or rewarding conditions in social or material contexts (Der-Avakian & Markou, 2012; Treadway & Zald, 2011). Activity in these two systems may be negatively correlated, as it is unusual to be simultaneously aroused by threat and appetitive incentives (although they may be dissociated in experimental conditions by a pharmacological manipulation, Coch et al., 2019).

Our investigation aimed at verifying the hypothesis of a relationship between negative cognitions (as elicited by the SST) and the internalization subspace of the PID. We characterized this relationship with three models. The first involved the predictors negative affectivity and detachment scores simultaneously, to reciprocally adjust for the confounding introduced by their natural association and uncover specific associations with negative cognitions. A second model involved an overall 'internalization score' obtained by combining these two scores, to characterize the magnitude of the variance of negative cognitions across individuals in the internalization subspace. Finally, a third model involved all PID-5 scales simultaneously, to investigate the specificity of the association with the internalization subspace. These models were estimated in three separate studies in which the experimental conditions were varied to verify replicability and external validity (for an overview, see Table 1). We used the computerized version of the SST (Viviani, Dommes, et al., 2018) but, unlike our previous studies, which were conducted in the laboratory, we collected the data online through a web-based application (due to the restrictions of the COVID-19 pandemic).

Study	SST target words	CES-D	PID-5-BF	PID-5-BF+	NEO-FFI	Questions
1	positive/negative	√	√			negative cognitions across PID domains
2	positive/negative	√		√	√	negative cognitions across PID domains (replication) effect of response times on sentence choice negative cognitions across five-factor model
3	positive/negative, positive/neutral, negative/neutral	√		√		negative cognitions across PID domains (replication) differential effects of negative affect and detachment on positive and negative word targets

Table 1. Overview of studies.

We further investigated several secondary hypotheses. First, because negative affectivity and detachment are associated with neuroticism and extraversion in the NEO-FFI inventory of the Five-Factor Model (Al-Dajani et al., 2016), we were interested in documenting the prevalence of negative conditions in this model, with which numerous studies have been conducted in the past. To our knowledge, no study has investigated the occurrence of negative cognitions in extraversion. Second, because the SST is thought to reveal a depressive disposition beyond current levels of depressive symptoms, we tested the association of cognitions with the internalization subspace after adjusting for depressive symptoms measured with the CES-D scale (Radloff, 1977). We will present evidence suggesting that the residual association with internalization scores prevalently affects detachment. Finally, we pursued the question of whether the SST may differentiate between negative affectivity and detachment by looking at differential associations depending on the nature of the word targets (negative/aversive or

positive/appetitive). We will present evidence of a preferential association of detachment with positive word targets, while negative affectivity appears to be more sensitive to negative word targets. This result is consistent with the above theoretical characterization of these two PID-5 domains in terms of distinct motivational systems and provides first empirical data on which future studies about the inner cognitive structure of the psychopathology of internalization may be based.

Results

In all the following models, we used a repeated-measurements mixed effects logistic regression for the choice of a positive sentence, so that negative coefficients indicate a tendency towards negative cognitions. Hence, the coefficient of a depressive symptoms scale is expected to be negative, as higher depression scores should be associated with more sentences that are negative. Except for sex, all coefficients refer to standardized predictors (see Methods for details).

Study 1: negative cognitions and PID domains

Study 1 (N = 204) used "optimism/pessimism" sentences (Viviani, Dommes, et al., 2018) to test the association of cognitions with the five domains of the DSM-5 (negative affectivity, detachment, antagonism, disinhibition and psychoticism) assessed with the 25 item PID-5 scale, with participants given 7.5 sec. to form a sentence. First, however, we verified that the formation of positive sentences was negatively associated with current depressive symptoms scores from the CES-D scale as a check that the SST was working as intended (Viviani, Dommes, et al., 2018). As expected, we detected a strong association (for test statistics and significance values, see Table 2, Model 1.1). In this as in all subsequent models, we adjusted for sex and age.

We then turned to the main question of study 1, i.e., the association of cognitions elicited by the SST with PID-5 personality domains. In the model in which we simultaneously included negative affectivity and detachment as predictors, both were strongly negatively associated with positive sentence rates, confirming our hypothesis (Model 1.2a). They also appeared to capture different aspects of personality associated with negative cognitions since in this model the effect of one was adjusted for the effect of the other. When depressive symptom levels were added to adjust for current levels of depressiveness, the effect of negative affectivity decreased, whereas the effect of detachment remained largely intact (Model 1.2b).

We then proceeded to assess the possible association of positive cognitions with all domains of the PID-5 simultaneously to verify the extent to which the expected association with the internalization subspace was specific. This analysis confirmed the significant association of positive sentence rates and negative affectivity and detachment. In the other domains, a smaller association with antagonism was detected. Disinhibition and psychoticism showed no association with the rate of positive sentences (Figure 2A and Model 1.3 in Table 2).

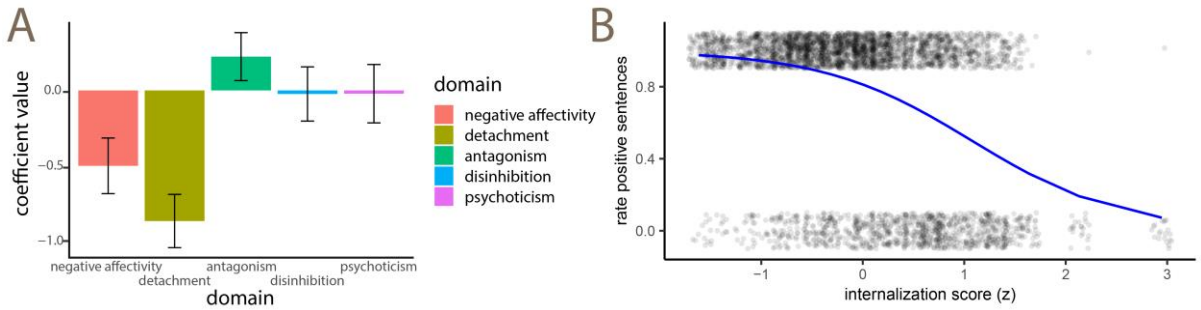

Figure 2 A: Study 1, model coefficients for selection of positive sentences and PID domains (90% confidence intervals). A negative coefficient means an increased tendency to form negative sentences with higher PID scores. B: fitted rate of positive sentences vs. internalization scores. The jittered points are positive and negative sentences.

To assess the magnitude of the effect of negative affectivity and detachment on the cognitions elicited by the SST, we estimated a model with an overall score obtained by averaging the standardized PID-5 scores of both negative affectivity and detachment ('internalization score'). In this model, individuals with average age and average internalization scores formed positive sentences at an average rate of 81%. An increase of one standard deviation in the internalization score reduced this rate to 53% (Figure 2B and Model 1.4 in Table 2). As is apparent from Figure 2B, positive sentences were expected to be a minority at two standard deviations of the internalization score. However, there were only two individuals with such high scores. To verify the influence of these two individuals, we repeated the fit without them, confirming the result ($z = -10.19$, $p < .001$).

Table 2. Statistical analysis of study 1.

Predictor	coefficient	std. error	*z*	significance
Model 1.1				
Depressiveness	−.96	.11	−9.08	< .001
Age	.24	.11	2.11	.03
Female sex	.15	.22	.67	.50
Model 1.2a				
Negative affectivity	−.48	.11	−4.43	< .001
Detachment	−.86	.10	−8.30	<.001
Age	.11	.10	1.05	.29
Female sex	.02	.21	.08	.94
Model 1.2b				
Negative affectivity	−.25	.12	−2.09	.04
Detachment	−.71	.11	−6.74	<.001
Depressiveness	−.46	.12	−3.96	<.001
Age	.11	.10	1.14	.26
Female sex	.01	.20	.05	.10
Model 1.3				
Negative affectivity	−.50	.11	−4.46	< .001
Detachment	−.87	.11	−8.07	<.001
Antagonism	.22	.10	2.32	.02
Disinhibition	−.02	.11	−.22	.83
Psychoticism	−.02	.12	−.18	.85
Age	.12	.10	1.12	.26
Female sex	.07	.21	.32	.75
Model 1.4				
Internalization	−1.36	.12	−11.00	< .001
Age	.08	.10	.79	.43
Female sex	1.2	.21	.60	.55

All coefficients except sex refer to standardized predictors. Significance levels are two-tailed.

Study 2: replication of study 1, response times, five-factors model

In study 2 (N = 119), we used a 34-item version of the PID questionnaire (PID-5-BF+; Kerber et al., 2022), which included, in addition to the five DSM-5 domains in the first study, also the ICD-11 domain anancasm (resulting in six domains) and the same set of SST-sentences as in study 1. This study also differed from all others in that there was no time limit for participants to form a sentence. These variations were intended to verify that the results of study 1 did not depend on details of the experimental procedure.

As in study 1, we preliminarily verified the existence of a negative association with current depressiveness measured with the CES-D (Table 3, Model 2.1). We then replicated the association with negative affectivity and detachment of the study 1 (Model 2.1a). After adjusting for current levels of depressive symptoms given by the CES-D, the effect of detachment remained intact, while negative affectivity reached only trend levels of significance (Model 2.1b). When including all six PID-5 domains in the model, the effects of negative affectivity and detachment were retained. There was a negative association with antagonism, which barely reached significance. No association was detected between positive sentence rates and anancasm, psychoticism, and disinhibition (Figure 3A and Model 2.3). The fitted positive sentence rates as a function of the internalization scores are shown in Figure 3B (Model 2.4). Here, individuals with average internalization scores formed 74% positive sentences on average; according to the fitted model, an increase of one standard deviation reduced this expected rate to 49%. In short, study 2 replicated all findings of study 1 except for the effect on antagonism on positive sentences rates. Anancasm showed no association with positive sentence rates.

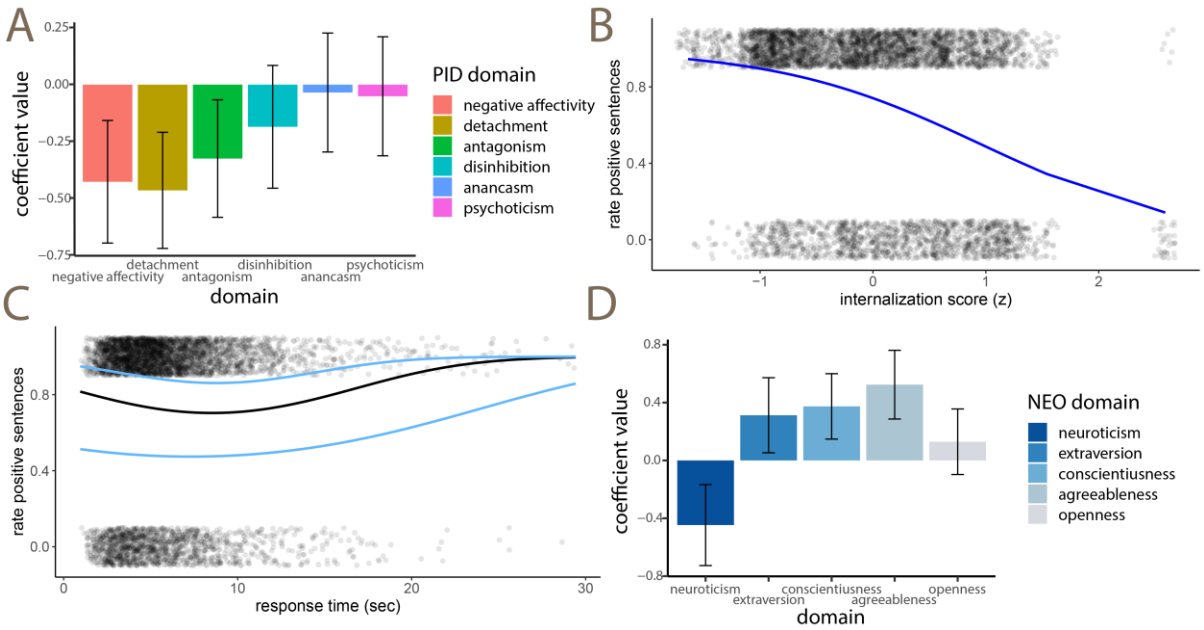

Figure 3. A: Study 2, model coefficients for selection of positive sentences and PID-5 domains (90% confidence intervals). The larger coefficient intervals, relative to study one, are consistent with the smaller sample size. B: fitted rate of positive sentences vs. internalization scores. C: effect of response times on positive sentence rates. In black the effect for average internalization scores; in light blue, estimated rates for individuals one standard unit more or less than average internalization. The jittered points are positive and negative sentences. D: model coefficients for selection of positive sentences and NEO personality factors (90% confidence intervals).

Study 2 also offered the opportunity to verify the moderating role of the time taken to produce sentences on the association with personality traits, as no time limit was given to form sentences. A previous study showed little interaction between response times and the association of sentences with depressive symptom levels (Viviani, Dommes, et al., 2018). Here, we looked at the effects on the internalization scores, which was the most effective predictor of negative sentences, testing a linear and a quadratic model for the standardized response times (as in that previous study). Here too, there were no significant interactions between response times and association of responses with the individual internalization score (linear and quadratic terms, $z = 1.22, -1.40$, $p = 0.22, 0.16$). As shown in Figure 3D, the distance between the blue lines showing the fitted rate of positive sentences at one standard deviation of internalization scores above and below the average remained the same for at least 15 seconds in this sample (variations in the distance correspond to the interaction). Beyond that time, there are too few observations to draw definitive conclusions, but what we see is consistent with previous findings (Viviani, Dommes, et al., 2018). Alternative modelling (logs of response times, excluding excessively long response times, adding a cubic term) led to qualitatively identical conclusions (not shown here for brevity).

In the second part of study 2, we looked at the association between positive sentence rates and the five personality factors (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) measured with the NEO-FFI inventory. As expected, both neuroticism and extraversion were strongly associated with the choice of positive sentences, but in different directions (as extraversion cores are in the opposite direction of detachment; see Model 2.5 in Table 3). Combined, these two personality traits were strongly associated with positive sentence rates (Model 2.6). To assess the specificity of these associations, we estimated a model with all NEO-FFI factors, thus adjusting for a possible association between them. This model revealed that all NEO factors except openness were associated with depressive cognitions (Figure 3D and Model 2.7). The association with neuroticism and extraversion was maintained, while conscientiousness and agreeableness were also positively associated with positive sentence rates. In this study, female participants had higher positive sentence rates than males after adjusting for depressive symptoms or personality traits. However, this finding was not replicated in the other studies.

Table 3. Statistical analysis of study 2.

Study 2, first part				
Predictor	coefficient	std. error	*Z*	significance
Model 2.1				
Depressiveness	−1.06	.16	−6.69	< .001
Age	.06	.14	.44	.66
Female sex	.79	.30	2.64	.01
Model 2.2a				
Negative affectivity	−.49	.16	−3.10	.002
Detachment	−.61	.15	−3.98	<.001
Age	.12	.15	.77	.44
Female sex	.65	.31	2.11	.04
Model 2.2b				
Negative affectivity	−.27	.16	−1.67	.095
Detachment	−.38	.15	−2.50	.01
Depressiveness	−.80	.17	−4.79	<.001
Age	.04	.14	.30	.76
Female sex	.80	.29	2.71	.007

Model 2.3				
Negative affectivity	−.42	.16	−2.57	.01
Detachment	−.47	.16	−3.01	.003
Antagonism	−.31	.16	−1.98	.048
Disinhibition	−.19	.17	−1.13	.26
Psychoticism	−.06	.16	−.39	.70
Anancasm	−.02	.16	−.09	.93
Age	.13	−15	.86	.40
Female sex	.42	.30	1.37	.17
Model 2.4				
Internalization	−1.10	.19	−5.67	< .001
Age	.11	.15	.72	.47
Female sex	.68	.30	2.5	.02
Study 2, second part				
Model 2.5				
Neuroticism	−.60	.17	−3.42	< .001
Extraversion	.50	.16	3.02	.003
Age	.04	.15	.26	.79
Female sex	.77	.30	2.58	.01
Model 2.6				
Negativity	−.94	.15	−6.45	< .001
Age	.04	.14	.30	.76
Female sex	.74	.29	2.57	.01
Model 2.7				
Neuroticism	−.45	.17	−2.62	.009
Extraversion	.31	.16	1.98	.047
Agreeableness	.52	.14	3.63	<.001
Conscientiousness	.37	.14	2.72	.007
Openness	.13	.14	0.94	.25
Age	.07	.13	.50	.61
Female sex	.20	.29	.62	.53

All coefficients except sex refer to standardized predictors. Significance levels are two-tailed.

Study 3: differential effect of negative and positive word targets

In study 3 (N = 194), we developed a new battery of sentences (30 sentences) by expanding the pool of sentences of previous studies (Viviani et al., 2010; Viviani, Dommes, et al., 2018; Viviani, Mahler, et al., 2018). Each sentence in this revised battery came with an additional neutral/uncharacterized target word (for example, ‘the future is bright/dismal/distant). In individual trials, only two of these target combinations were on offer, giving three possible trial variants of the same sentence: positive/negative [PN], as in the previous two studies; positive/neutral [PU]; and negative/neutral [NU]. We intended here to investigate the differential effect of positive and negative target words on the association with personality domains. In the Introduction, we postulated a relationship between negative affectivity and negative interactions with the world, and one between detachment and positive incentives. On this basis, we hypothesized that negative affectivity would load more strongly in the presence of a negative target word, while the presence of a positive target word would be more strongly associated with detachment scores.

We first modelled the data as in the previous studies, disregarding the new variation in target word combinations, to replicate the findings of study 1 and 2. The strong association between depressiveness and the choice of positive sentences was present also in this dataset (Model 3.1 in Table 4). As in the previous studies, positive sentences were negatively associated with both PID-5 domains negative affectivity and detachment (Model 3.2). Combined into an internalization score, these two scales showed a very strong negative association with the choice of positive sentences (Model 3.3a). Also in this sample, when depressive symptoms

levels were included as a confounder in the model, the effect of negative affectivity scores greatly diminished, while the negative association between detachment and positive sentences remained significant (Model 3.4). In the model that included all six PID-5 domains (Model 3.5), the association of sentences and negative affectivity and detachment was retained and was specific (Figure 4A); only the association with antagonism reached trend-level significance. In short, we replicated the findings of studies 1 and 2, with the possible exception of the effect of antagonism.

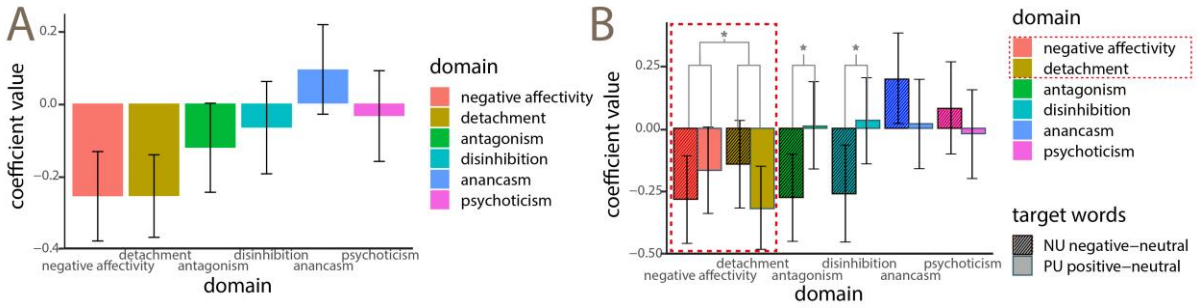

Figure 4. A: Study 3, model coefficients for selection of positive sentences and PID-5 domains (90% confidence intervals). A negative coefficient means an increased tendency to form negative sentences with higher PID-5 scores. B: separate model coefficients for negative-neutral [NU] and positive-neutral [PU] target combinations (means and 90% intervals from posterior draws from a Bayesian model, as described in the Methods). The asterisks mark significant interactions (90% intervals excluding zero).

We then looked at the effect of the new variation in target word combinations. [PN] combinations, which are the standard combination in the SST, were better than the other combinations at eliciting associations with internalization scores. One standard deviation in these scores decreased the positive sentence rate from 75.7% to 61.1% in sentences with these target words, while this rate decreased from 66.0% to 54.8% in pooled [PU/NU] combinations (by 14.7% and by 11.2% respectively, interaction $z = -1.66$, $p = .097$, two-tailed). Nevertheless, the association with internalization was present also in the [NU] combination, which was the least effective in this respect ($z = -3.93$, $p < .001$). However, our main purpose here was to test a second-order interaction between negative affectivity/detachment and [PU/NU] combinations. We expected negative affectivity to be more sensitive to the presence of the negative word target, and detachment to the positive word target (as explained in the Methods, we report the fit from a Bayesian approach for this complex model because of difficulties in obtaining the fit with restricted maximum likelihood and because this approach delivers reliable estimates of contrasts). As shown in Figure 4B (outlined by a dashed red line), the interaction was present as hypothesized (contrast estimate from resampled posterior: 0.29, 90% credibility interval 0.002-0.58, quantiles: $p \sim .048$, one-tailed). This model also gave two incidental findings, the increased sensitivity of antagonism and disinhibition to the presence of the negative word.

Table 4. Statistical analysis of study 3.

Predictor	coefficient	std. error	z	significance
Model 3.1				
Depressiveness	−.40	.07	−6.16	< .001
Age	−.11	.15	−.71	.48
Female sex	.11	.07	1.66	.10
Model 3.2				
Negative affectivity	−.25	.07	−3.66	<.001
Detachment	−.29	.07	−4.45	<.001

Age	.04	.07	.54	.59
Female sex	.05	.15	.32	.75
Model 3.3a				
Internalization	−.55	.09	−6.44	<.001
Age	.04	.07	.53	.60
Female sex	.06	.15	.42	.68
Model 3.3b				
Internalization	−.34	.11	−3.11	.002
Depressiveness	−.23	.08	−2.77	.006
Age	.06	.07	.91	.36
Female sex	.13	.15	.90	.37
Model 3.4				
Negative affectivity	−.12	.08	−1.53	.13
Detachment	−.20	.07	−2.92	.004
Depressiveness	−.24	.08	−2.87	.004
Age	.06	.07	.95	.35
Female sex	.10	.15	.70	.48
Model 3.5				
Negative affectivity	−.26	.08	−3.41	<.001
Detachment	−.26	.07	−3.69	<.001
Antagonism	−.12	.07	−1.63	.10
Disinhibition	−.06	.08	−.86	.40
Psychoticism	−.03	.08	−.46	.65
Anancasm	.09	.08	1.25	.21
Age	.01	.07	.10	.92
Female sex	−.06	.12	−.39	.70

All coefficients except sex refer to standardized predictors. Significance levels are two-tailed.

Discussion

The main goal of the present study was to explore the relationship between dimensional characterizations of personality and negative cognitions. As assessed by the SST, negative cognitions were consistently and specifically associated with the internalization subspace of the PID-5. This association was present here even if participants were assessed through a web-based platform. The association with antagonism was inconsistent, possibly depending on the rating scale used.

In contrast, while also showing associations with cognitions in the expected direction, the FFM of personality elicited additional associations with personality factors except for openness. A number of studies have investigated the association between the factors or domains of the FFM with the Personality Inventory of the DSM 5 (Few et al., 2013; Helle et al., 2017; Quilty et al., 2013; Suzuki et al., 2017). These studies show considerable overlap between the PID-5 and the FFM, but the reported extent of the association varies (Al-Dajani et al., 2016), with the strongest correlation found for neuroticism/negative affectivity. Our findings suggest that beyond negative affectivity, differences between these scales may exist, with the FFM capturing aspects of optimistic cognitions in the healthy that are possibly left untapped by the PID-5. In our view, this comparison favours the PID-5 (which was redacted from inventories of symptoms) in clinical applications that intend to map internalization through the space spanned by these two dimensions, because of the increased specificity of this space. Our data also provide evidence of validity of these domains by providing associations with data from an experimental procedure such as the SST.

Because of the substantial body of research with the FFM, we will base our discussion also on that literature. Previous studies found all FFM factors to be associated with dispositional optimism except openness, consistently with our findings (see Sharpe et al., 2011 and

references therein). A meta-analysis by Hakulinen et al. (2015) showed that high neuroticism, low consciousness, and low extraversion were associated with depressive symptoms on both cross-sectional und longitudinal analysis, as in our data. Kotov et al. (2010) also found similar results in their meta-analysis: depressive symptoms were here characterized by high neuroticism, low extraversion, and low conscientiousness. Several long-term studies have been able to show that neuroticism predicts both the onset and the chronicity of Major Depressive Disorder (MDD) (Caspi et al., 1996; Clark et al., 1994; Krueger et al., 1996; Ormel et al., 2004). In contrast, the role of low extraversion is less well characterized. In long-term studies, low extraversion has been shown to predict the onset of MDD (Hirschfeld et al., 1989; Krueger et al., 1996). The facets of extraversion includes dominance, social extraversion and the tendency to experience positive emotions (Costa & McCrae, 1992; Digman, 1990; McCrae & Costa, 1997). Extraversion/Positive Emotionality was reported to be significantly lower in remitted patients than in healthy controls (Hirschfeld et al., 1983; Reich et al., 1987). Hence, the associations detected here between negative cognitions and the internalization subspace of the PID-5 are consistent with pre-existing data from the five factors model.

In our data, negative cognitions appeared to be associated with detachment irrespective of adjusting for current depressive symptom levels, in contrast to the association with negative affectivity. Furthermore, negative affectivity and detachment appeared to differ in their sensitivity to positive and negative target words, as one would expect from models mapping these two dimensions to reactivity that is increased for negative environmental events and decreased for appetitive incentives (Krueger & Markon, 2014). Within the FFM, the dissociation between neuroticism and extraversion has been reported as a differential response to pharmacological therapy and psychotherapy of depression (Tang et al., 2009). While our finding barely reached the threshold for rejection and therefore needs to be replicated in future studies, the residual association with detachment after adjusting for depressiveness and the differential association with the valence of the target words is remarkable in view of the existing data on the SST as a predictor of future depressive episodes (Rude et al., 2002). Together, these findings suggest a distinct source of depressive disposition, not entirely captured by current depressive symptom levels and related to an anhedonic personality trait, but still related to cognitive tendencies, and that should be investigated further.

An important issue for future studies concerns the clarification of the nature of the process underlying the selection of cognitions in the SST. Although conceived at the time in terms of the failure of control processes in preventing negative content to prevail (Wenzlaff & Wegner, 2000), it has become increasingly difficult to sustain this original model. Neuroimaging studies, which have been very consistent, show no trace of increased recruitment of cortical substrates of executive function in the SST or of an association with individual differences in working memory capacity (Viviani et al., 2010; Viviani, Dommes, et al., 2018; Viviani, Mahler, et al., 2018). However, it would be equally difficult to attribute selection of sentences in the SST to an automatic process. The lack of an effect of response times on the associations elicited by the SST suggests selection of sentences to be deliberate. In our experience, in these circumstances participants are fully aware of the alternative sentences irrespective of the instruction given to them. Nevertheless, the reliable and at times complex statistical patterns in

SST data indicate that these choices, even if deliberate, reveal systematic tendencies irrespective of whatever intentions participants had in making them.

A possible interpretation of this pattern of findings comes from the same neuroimaging studies, which show an overlap of neural substrates between the SST and tasks of preference-based choice (Viviani et al., 2010; Viviani, Dommes, et al., 2018; Viviani, Mahler, et al., 2018), instead of the substrates of executive function as originally expected. This parallel is of interest also because of the large amount of studies that demonstrate the sophistication of mechanisms used to synthetize diverse sources of information about options into the criterion of a binary preference choice, 'subjective value' (Krajbich et al., 2010; Labek et al., 2021; O'Doherty, 2011; Rangel & Hare, 2010; Viviani et al., 2020). Like selection of sentences in the SST, preference-based choice is both deliberate and consistent, and may take motivational factors into account (Bray et al., 2008). Extending the preference-based choice model to the present setting, the selection of cognitions may proceed through the computation of the 'subjective value' of the available cognitive options, which may in this case reflect schematic plausibility of the alternative sentences (Viviani, Dommes, et al., 2018) as well as the effect of motivational processes triggered by the negative and positive target words (Viviani, 2014). At present, however, preference-based choice as a distinct process type remains a neglected option in process models of affective disorders (Messina et al., 2016), which instead favours models based on the contrast between controlled and automatic processes (DeRubeis et al., 2008; Disner et al., 2011).

Methods

All studies were approved by the Ethical Review Board of the Institute of Psychology of the University of Innsbruck. All studies were conducted during the COVID-19 pandemic. For this reason, all data collection took place online through web interfaces.

Scrambled Sentences Task (SST)

The SST was originally developed to assess the underlying cognitions of depression (Wenzlaff & Bates, 1998; Wenzlaff & Wegner, 2000). Today, several alternative forms of SST (Social Phobia, Antisocial Cognitions) have already been developed (Kienhöfer, 2019; Viviani, Dommes, et al., 2018). In SST, 6 words are presented at a time on which you can form 2 variants of a sentence. These differ from each other in their last word. These last two words represent the targets. The subjects are thus presented with six words each in different trials, which they are put in the correct order mentally.

In this example, the variants "the future is quite bright" and "the future is quite dark" can be formed. Exemplary word constellations with depressive connotations from the test by Wenzlaff and Bates are: "interesting life my boring generally is", "usually like people not me do", "love I others' don't deserve generally" or "worthwhile I worthless am a person". In healthy people, it can be observed that only 20−30% of sentences are spontaneously formed negatively (Viviani et al., 2010). In depressed patients, the proportion of negative sentences is greater. The relative number of negatively or positively ended sentences thus allows conclusions to be drawn about a possible depressive illness, since the number of statements with negative connotations correlates strongly with other measurement instruments of depression. These results justify

using the SST as an experimental procedure that allows the measurement of individual propensity to negative cognitions.

The original task was carried out by hand as a paper-pencil test. In this study, we used the online version of the test (Viviani, Dommes, et al., 2018). The individual sentences are composed so that they each contain two target words and one anchor word, i.e. the word to which the target words refer (see Figure 1). Positive and negative target words occur equally often on the left and the right. Target words are also equally distributed with respect of their position in the scrambled sentence and the distance to the anchor word. Both the length and the frequency of positive and negative target words are matched, based on a database of the written German language (Institut für deutsche Sprache, 2013); for details, see (Viviani, Dommes, et al., 2018). In study 3, where the targets words were revised for the present experiment, target words were matched for length and frequency in the [NU] (frequency: $z = .08$, $p = .94$; length: $z = -.46$, $p = .64$), [PU] (frequency: $z = -.72$, $p = .47$; length: $z = .48$, $p = .63$), and [PN] (frequency: $z = .79$, $p = .43$ length: $z = .95$, $p = .35$) target word combinations.

Participants that completed too few sentences (7 or more misses or errors) or logged on more than once to the system were excluded from analysis.

Psychological assessments

Personality Disorder Questionnaires PID-5. The DSM-5 Section III (Alternative Model of Personality) formulates criteria for the level of functioning of the self and interpersonal aspects (criterion A) and for the presence of specific pathological trait-domain constellations (criterion B). These latter were assessed in the present study. The trait-domain taxonomy includes 25 trait-facets, with specific facets combined as indices for the five broader trait-domains: negative affectivity, detachment, antagonism, disinhibition, and psychoticism. Due to differences in the fifth domain between the DSM-5/AMPD and the ICD-11, various PID-5 versions are now available. In the current work, in study 1 we used the PID-5-BF (Krueger et al., 2012; Krueger et al., 2013). This scale includes 5 items per domain for a total of 25 items. Each item on the measure is rated on a 4-point scale from 0=very false or often false to 3=very true or often true). Higher scores indicate greater impairments in the specific personality trait domain. In the second and third study we adopted the PID-5-BF+ (Kerber et al., 2022). This scale includes 34 items that captures the five domains of the PID-5, and a sixth domain, anancasm. Each item is rated on a scale from 0 (does not apply at all) to 3 (applies fully). The PID-5-BF is suitable for assessing maladaptive personality traits according to both the DSM-5/AMPD and the ICD-11.

Five-Factor Model of Personality (FFM) The FFM or “big-five” includes the factors neuroticism, extraversion, openness to experience, agreeableness and conscientiousness (Costa & McCrae, 2009). The NEO-Five-Factor Inventory (NEO-FFI, Costa & McCrae, 1989; German Version: Borkenau & Osterdorf, 2008) is an established 60-item self-report measure of these five factors (12 items for each factor). The questions are each answered using a five-point Likert scale ranging from "strongly disagree" to "strongly agree".

Depression symptom levels were measured with the German version of the Centre for Epidemiologic Studies Depression Scale (CES-D, Radloff, 1977; German Version: Hautzinger & Bailer, 1993) a scale developed for the study of community samples. The scale includes 20

items regarding how the subject may have felt or behave in the last week. Participants assessed each item on a 4-point Likert scale ranging from 0 (rarely or none of the time, less than 1 day) to 3 (most or all the time, 5–7 days).

Overview of studies

Participants were recruited among the students of the University of Innsbruck as a part of their requirement to complete their studies. Students were made aware of the studies through email. The purpose and intentions of each study were explained, and the voluntary nature of participation was sated. Participants were informed about the confidential handling of their data; the data and study results were collected anonymously. The subjects gave their consent to participate prior to the study and were informed that leaving the page would be considered as a withdrawal from the survey, in which case no data would be recorded.

Study 1. Two types of sentences were used in the SST: optimism/pessimism sentences (Viviani, Dommes, et al., 2018) and sentences in which both response options were neutral (e.g., "spring is her birthday in summer"). Each subject processed 42 sentences, 20 of which were from the neutral category, which were not included in the present analysis. Half of all sentences had self-related content (e.g., "the worries future gives me pleasure"). The processing time per sentence was limited to 7.5 seconds. The brief form of the Personality Inventory for DSM-5 (PID-5-BF) was used to assess the pathological personality traits. Participants depressiveness was assessed with the German version of the CES-D.

In the recruited sample (N = 220), 16 participants were excluded due to an excessive number of failures to complete the sentences (more than 7), suggesting that the task was not being executed accurately. The final sample contained N = 204 participants (140 females, 2 gender-diverse; age mean 23.1, std. deviation 6.5). The correct sentence rate in the retained sample was 89.5%.

Study 2 was conducted with the same optimism/pessimism sentences as in study 1 (Viviani, Dommes, et al., 2018), but participants were given no time limit to complete the sentence. In addition, the subjects completed sentences for the assessment of social phobia (e.g., "new situations are usually exciting/intimidating"; Kienhöfer, 2019), which were not used in the analysis. In this study, the PID-5-BF+ was used for the AMPD personality domains, the NEO-FFI to assess the factors of the FFM, and the CES-D to assess depressiveness.

In this study, N = 129 participants took part, and N = 119 were admitted to the analysis after excluding those who failed to complete more than 7 sentences (80 females, 1 gender-diverse; age mean 24.8, standard deviation 7.4). The correct sentence rate in the retained sample was 97.2%.

Study 3. The optimism/pessimism sentences were revised by additionally developing sentences with one neutral target. For each sentence, this results in three different versions of target word combinations (positive/negative [PN], positive/neutral [PU], and negative/neutral [NU]). This version of the SST presented 30 sentences to each subject. Only one version of target combination was presented, varying the selected version across the sample to collect data on all versions for each sentence. In this study, the PID-5-BF+ was used for the AMPD personality

domains and the CES-D to assess depressiveness. Participants also completed he LPFS, a rating scale to assess Criterion A of the AMPD. LPFS scores will be analysed in a future publication.

In this study, N = 194 participants were recruited. After excluding participants who failed in more than 7 sentences or executed the task repeatedly (N = 170), we obtained a sample with 126 females (mean age: 22.9, standard deviation 6.8) with a correct sentence rate of 89.5% (30 sentences).

Statistical analysis

Data were fitted with a mixed-effects logistic regression with the formation of a positive sentence as the outcome binary variable, age and sex as covariates, and subjects and sentences as crossed random effects. All predictor variables were standardized except for sex. All models were fitted in R with two packages: a package estimating the fit through restricted maximum likelihood (*lme4*, Bates et al., 2015) and one using a Bayesian approach (*rstanarm*, Goodrich et al., 2020) which implements Hamiltonian Monte Carlo through the *stan* engine. The Bayesian package provides default weak informative priors, which we adopted. We used four chains with 2000 iterations, of which 1000 were warm-ups and 1000 were samples from the posterior distribution.

The *lme4* package provides a convergence diagnostic with a stringent cut-off to signal problems, which failed to be satisfied in a few of the fitted models, particularly when interactions between within-subjects and between-subjects predictors were modelled. The *stan* engine provides numerous diagnostics for problems in resampling the posterior distribution; in all models we fitted, these diagnostics reported no problems (effective sample size and 'Rhat' index of converge between chains). The Bayesian approach may also be more accurate in estimating coefficient internals as it better propagates uncertainty from estimates of random effects. We compared fits and coefficient intervals between these two packages in all models, finding almost identical outcomes. We therefore report frequentist significance levels from *lme4*, except for statistics not available with this package (for example, estimates of linear contrasts). In such cases (as in Figure 4B), we report 'credibility' intervals from the resampled posteriors of the Bayesian package, which, when not including zero, may be interpreted as providing evidence for the existence of an effect for non-directional (5% intervals) and directional (10% intervals) hypotheses.

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Availability of data and software

The SST software used in the present study is available with the original sentences (in German) from Roberto Viviani. Data are available on request after verifying that further analyses are compatible with the aims stated in the consent form signed by participants. The study was registered with the DOI 10.17605/OSF.IO/8RB6J.

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