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Running head: NOVELTY SEEKING AND CREATIVITY

Novelty seeking is linked to openness and extraversion, and can lead to greater creative  
performance

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#### **Authors note**

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### Abstract

**Objective:** Novelty seeking (the tendency to explore things novel and unfamiliar) has been extensively researched in the clinical and health domains, but its effects on creative performance are largely unknown. We asked whether creativity-related personality traits (openness to experience and extraversion) associate with novelty seeking, and whether novelty seeking is linked to, and facilitates, creativity. **Method:** In Study 1a ( $N = 230$ ,  $M_{age} = 20$ , 64% females) and Study 1b ( $N = 421$ ,  $M_{age} = 19$ , 65% females) we measured extraversion, openness to experience, novelty seeking, and divergent thinking. To provide causal evidence for the relation between novelty seeking and creativity, in Study 2 ( $N = 147$ ,  $M_{age} = 27$ , 75% females) we manipulated people's motivation to seek novelty, and measured subsequent divergent thinking. **Results:** In Studies 1a and 1b we demonstrated that trait novelty seeking is associated with openness and extraversion on the one hand, and divergent thinking on the other. In Study 2 the novelty seeking manipulation led to greater divergent thinking. **Conclusions:** We conclude that novelty seeking is linked to openness to experience and extraversion, and that it can lead to greater divergent thinking.

Keywords: creativity, novelty, exploration, openness, extraversion

Novelty seeking (the tendency to explore things novel and unfamiliar) has been extensively researched in the clinical and health domains, but its effects on cognitive performance are largely unknown. In contrast to pessimistic findings that link novelty seeking with substance abuse and antisocial behavior (Bulik, Sullivan, Weltzin, & Kaye, 1995; Hesselbrock & Hesselbrock, 1992; Krebs, Weyers, & Janke, 1998), we propose that there are also positive aspects to novelty seeking. Because creative ideas tend to be novel, we asked whether novelty seeking is linked to (Study 1) and leads to (Study 2) greater creative performance. Additionally, because novelty seeking is linked to the dopaminergic brain network (DeYoung, 2013; Ebstein et al., 1996), we asked whether novelty seeking is associated with the dopamine- and creativity-related personality traits of openness to experience and extraversion (Study 1).

Uncovering a link between novelty seeking and creative performance is important because it could help develop interventions aimed at increasing people's creativity. Creativity researchers have been successful in identifying who is creative and in what domains, but have paid scant attention to the more specific processes that produce creative success. For instance we know that people who are open to experience score higher in divergent thinking (McCrae, 1987), and achieve greater success as musicians, visual artists, and writers (Kaufman et al., 2016), but we know very little about what these individuals do that enables their greater creativity. In addition to inquiring about broad personality traits that predict creativity, asking about concrete, well-defined behavioral tendencies that are associated with greater creative thought is very useful. Narrowly defined processes are easier to manipulate and increase experimentally. Because novelty seeking is such a concrete and well-defined behavioral tendency, it could potentially be increased in experimental settings. And if increased novelty seeking can *cause*

greater creativity, this can potentially lead to developing new interventions aimed at increasing creativity.

### **Novelty Seeking and Personality**

Novelty seeking refers to “the tendency of humans and animals to explore novel and unfamiliar stimuli and environments” (Costa, Tran, Turchi, & Averbeck, 2014). Novelty seeking is a specific, lower-level and relatively content-free (i.e., not *limited* to the domain of culture, intellect, social interaction, etc.) behavioral tendency. It is associated with greater sensation seeking (Mallet & Vignoli, 2007), impulsivity (Wills, Vaccaro, & McNamara, 1994), risk taking, and a greater orientation towards independence (Wills et al., 1994), as well as greater extraversion and openness to experience (Gordon & Luo, 2011). Novelty seeking is thought to depend on dopaminergic brain-functioning (Ebstein et al., 1996). Novel stimuli excite dopamine neurons and activate brain regions receiving dopaminergic input, which suggests that novelty constitutes, at least in some situations or for some individuals, an intrinsically rewarding stimulus (for a review, see DeYoung, 2013).

Novelty seeking shares a lot of commonalities with, and could thus be associated with the Big Five personality traits of extraversion and openness to experience. Indeed, some correlational data seems to suggest a link (Gordon & Luo, 2011). In addition, research on plasticity (the shared variance of openness and extraversion; Silvia, 2008), shows that openness to experience as well as extraversion are linked to dopaminergic brain functioning, and that the common core of these traits reflects a “tendency to explore or engage voluntarily with novelty” (DeYoung, Peterson, & Higgins, 2002, p. 535). According to this approach, both extraversion and openness are rooted in a preference for novelty (DeYoung, 2013), however extraverts should be more likely to explore and investigate novelty in a physical, behavioral sense, while

individuals high in openness should, on the other hand, be more likely to “explore abstractly, altering current categories and reconceptualizing or renovelizing” (DeYoung et al., 2002).

According to this view, both openness and extraversion are linked to novelty seeking, but they are linked to novelty seeking in a *unique* way, with each of the traits explaining a somewhat different portion of variance in novelty seeking behavior.

*Hypothesis 1: Openness to experience and extraversion uniquely predict novelty seeking.*

This hypothesis suggests that extraversion and openness should predict novelty seeking even when their common variance is controlled for, that is, even when novelty seeking is regressed on both of these personality predictors at once. To test this hypothesis, in Studies 1a and 1b we measured novelty seeking and looked at whether this behavioral tendency is *simultaneously* predicted by both openness to experience and extraversion.

### **Trait Novelty Seeking and Creativity**

Novelty seeking may determine crucial decisions made by most living beings, and across countless domains: from trying new but possibly deadly food products, to forming alliances with out-group members, to allocating a nation’s budget towards innovative but costly ideas (Cohen, McClure, & Yu, 2007). From an evolutionary standpoint, novelty seeking should be crucial in complex and dynamic environments, because it will push organisms to explore a variety of novel possibilities that can serve as a means for survival (Costa et al., 2014). Despite its great potential for adaptability, flexibility, and greater creative performance (Gallagher, 2011), novelty seeking has been largely under-researched in those domains. In clinical settings the tendency is typically perceived as maladaptive, as it is associated with addiction, anti-social behavior, and excessive risk taking (Wills et al., 1994). Whether there are any positive aspects to novelty seeking, like effects on creativity, has not been thoroughly studied.

Although research linking people's novelty seeking tendencies with creativity is scant, the link between these two variables is quite plausible. Creative outcomes are commonly defined as novel and useful (Amabile, 1983; Guilford, 1950), and rely on people's ability to retrieve novel and unusual associations (Mednick, 1962), and to recombine known schemas and objects in novel ways (Estes & Ward, 2002; Ritter et al., 2012). Generating creative (rather than uncreative) ideas should thus have incentive value for novelty seekers: people who like and seek out new things should find enjoyment in generating many new ideas or recombining these ideas in new ways. Consistent with the notion that novelty seekers should be more creative, several correlates of novelty seeking have been linked to greater creativity. In historiometric and anecdotal accounts, greater openness towards alternative styles and behaviors (Florida, 2002), or new cultural influences (Simonton, 1997), has been shown to be implicated in nation-level creativity and innovation. It is also worth noting that the same neurotransmitter that regulates novelty seeking also regulates openness, extraversion, and creativity (Boot, Baas, Van Gaal, Cools, & De Dreu, 2017; DeYoung et al., 2011). Because both openness and extraversion emerge as predictors of various types of creativity (Baas, Roskes, Sligte, Nijstad, & De Dreu, 2013; Silvia, Nusbaum, Berg, Martin, & O'Connor, 2009), the same can be expected for novelty seeking (Rietzschel, Nijstad, & Stroebe, 2014).

*Hypothesis 2: Trait novelty seeking predicts greater creativity.*

Despite these strongly suggestive links between novelty seeking and creativity, cross-sectional and experimental studies linking novelty seeking and creative thinking are scant. We could only find three studies investigating the link between novelty seeking and creativity. The first study looked at flexible information processing - participants' ability to form remote associations (Mednick, 1962). In this research, Houston and Mednick (1963) argued that

participants who scored high on the Remote Associates Test (RAT) were higher in novelty seeking, because on an unrelated task, they were more likely to choose words that were followed (vs. not followed) by novel words. However, a later study by Harris and Hall (1970) did not replicate these findings. A third and final study found medium-size correlations between the Torrance Test of Creative Thinking (Torrance, 1974) and exploratory excitability – one of four subcomponents of Cloninger’s novelty seeking temperament dimension (the other three components - impulsivity, extravagance, and disorderliness - were not linked to creativity; Chavez-Eakle, del Carmen Lara, & Cruz-Fuentes, 2006; Cloninger, Przybeck, & Svrakic, 1991). To the best of our knowledge, these three studies constitute the only known research testing the idea that novelty seeking is linked with greater creativity.

Unequivocally demonstrating that novelty seeking is linked to creativity is important, because it would help researchers understand what concrete behavioral tendencies enable creativity. To address this issue in Studies 1a and 1b we additionally (to novelty seeking, openness, and extraversion) measured divergent idea generation, and tested whether scores on this task can be predicted from novelty seeking. We chose divergent idea generation because it has successfully been used in classical creativity research (Guilford, 1967; Torrance, 1974) and remains a standard measure of creativity today (Boot, Baas, Mühlfeld, de Dreu, & van Gaal, 2017; Ritter et al., 2012; Vezzali, Gocłowska, Crisp, & Stathi, 2016).

### **State Novelty Seeking and Creativity**

In many businesses and educational institutions creativity and innovation are highly valued and, at times, explicitly required. Interventions to increase creativity are crucial and sought after by both individuals and organizations. A common finding in the creativity literature is that openness and extraversion are strong predictors of creativity. Openness is perhaps the



single best predictor of creativity (McCrae, 1996; Scratchley & Hakstian, 2010; Williams, 2004). Extraversion, on the other hand, predicts creative achievement in the arts (Kaufman et al., 2016) and performance on divergent thinking tasks in ordinary samples, but is less related to the creative achievements of geniuses and prodigies (Batey & Furnham, 2006). Unfortunately, because both personality traits constitute very broad constructs, it is very hard to test whether either of them can actually *cause* greater creative performance, and even harder to develop interventions that would aim at increasing creativity via increasing openness and/or extraversion. Novelty seeking, on the other hand, is a more narrowly defined construct, and it should be possible to manipulate it in an experimental context (Costa et al., 2014). If, as dopamine research suggests (Lhommé et al., 2014), novelty seeking really does increase creativity, then manipulations aimed at increasing state novelty seeking should also increase creative performance.

*Hypothesis 3: State novelty seeking increases creativity.*

Consequently, in Study 2 we manipulated participants' motivation to seek novelty, and looked at whether this type of intervention could *cause* successful divergent idea generation.

### **Pretest Study**

We conducted an initial, pretest study to establish a broad measure of novelty seeking. One hundred and five participants (University of Amsterdam psychology students, 66% females,  $M_{age} = 23$ ) completed the pretest study in return for a small monetary reward (5 Euro, approximately equivalent to 6 USD). In the study we provided participants with 14 items measuring novelty seeking (see Table 1). Nine of the items were similar to those used in the exploratory excitability subscale of the Cloninger's Temperament and Character Inventory (TCI; Goldberg, Johnson, Eber, Hogan, Ashton, Cloninger, & Gough, 2006), and were acquired from

the publicly available International Personality Item Pool (e.g., “I like to begin new things”; <http://ipip.ori.org/newTCIKey.htm#Variety-Seeking>)<sup>1</sup>; Five additional items were taken from the Personal Expansion Questionnaire (Gordon & Luo, 2011; e.g., “I usually seek out new opportunities or experiences.”). All items were scored on a five point Likert-type scale (1 = “strongly disagree” to 5 = “strongly agree”). For discriminant validity, we included items from the augmentation subscale of the Personal Expansion Questionnaire. Augmentation refers to “the capacity to expand one’s resources by gaining greater expertise, or depth, within a familiar domain” (Gordon & Luo, 2011). The augmentation subscale included items such as “I enjoy gaining a more thorough understanding of something I already know”, and in factor analysis these items have been shown to load on a separate factor than the Personal Expansion Questionnaire novelty seeking subscale items (Gordon & Luo, 2011). Our expectation was that the 14 novelty seeking items and the 5 augmentation items would load on separate factors in a Principal Component Analysis (PCA), with good reliabilities.

Once the data were collected, we conducted a PCA with the 19 novelty seeking and augmentation items entered together, specifying a two-factor solution with Varimax rotation (for a list of items and their factor loadings, see Table 1). Fourteen items (all novelty seeking items) loaded .45 or more on Factor 1 (Eigenvalue=6.33, 33% variance explained), suggesting that Factor 1 represents the construct of *novelty seeking* ( $\alpha=.90$ ). Five items (all augmentation items) loaded .45 or more on Factor 2 (Eigenvalue=3.02, 16% variance explained), suggesting that Factor 2 represents the construct *augmentation* ( $\alpha=.85$ ). The novelty seeking and augmentation

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<sup>1</sup> Two items overlapping in content (“I don’t like the idea of change”; “I dislike changes”) were collapsed into one: “I dislike change”.

measures were not correlated ( $r=-.02$ ,  $p=.84$ ). These measures were used in the studies that follow.

### **Studies 1a and 1b**

In Study 1a we looked to establish initial evidence of the relations of openness and extraversion with novelty seeking (Hypothesis 1), as well as between divergent idea generation and novelty seeking (Hypothesis 2). Study 1b provided an extension and refinement of those initial results. Study 1b used a sample size that was nearly twice as large as that of Study 1a, which allowed for a more powerful, and more reliable test of the hypothesized relations. In addition, in Study 1b, personality, novelty seeking and creativity were measured in separate testing sessions, weeks apart, allowing for a more conservative test of those relations.

### **Method**

#### **Participants and procedure.**

In Study 1a, participants were 230 University of Amsterdam psychology students enrolled in Dutch-speaking undergraduate courses (64% females,  $M_{age}=20$ ; ethics approval: 2013-WOP-3144). Study 1b was conducted one year later, with a different cohort of students from the same course ( $N=421$ ; 65% females,  $M_{age}=19$ , Ethics approval: 2014-WOP-3790)<sup>2</sup>. All participants completed the sessions in partial fulfillment of a course requirement.

The data for both studies were collected in a series of large testing sessions at the beginning of an academic term; the sessions were spaced weeks apart. In Study 1a the

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<sup>2</sup> To uncover effects of medium magnitude ( $r=.24$ , equivalent to  $d=.50$ ) with a power of .80 requires an  $N$  of at least 131 (Faul, Erdfelder, Buchner, & Lang, 2009). To achieve this power in Study 1a we tested half of the available student population, which we estimated to be between 200 and 225 participants (the remaining half of students completed a different study). In Study 1b we wanted to have the power to uncover even smaller effects (e.g.,  $r=.15$ , equivalent to  $d=.30$ ), so we decided to use the whole available student population, which we estimated to be between 400 and 450 participants.

personality measures were administered in one session, and the novelty seeking and creativity tasks were administered in another session. In Study 1b, the personality measures, novelty seeking, and divergent idea generation were administered in three separate sessions. During all testing sessions participants were seated in a large lecture hall at a personal computer that displayed all materials and recorded all responses. Experimenters supervised the testing sessions in which participants were required to work individually, at their own pace, and without consulting others. Participants completed the Big Five, the novelty seeking measure, and a battery of creativity measures<sup>3</sup> that included two 2-minute divergent thinking tasks.

In Study 1a, when the data from the two testing sessions were combined, 2 cases were missing for openness and extraversion, 3 for novelty seeking, and 9 for divergent thinking. In Study 1b, when data from the three testing sessions was combined, 10 cases were missing for openness and extraversion, 9 cases were missing for novelty seeking, and 20 cases were missing for divergent thinking.

### **Measures.**

**Novelty Seeking and Augmentation.** Novelty seeking and augmentation were assessed using the measures developed in the pretest. The variables had good or acceptable reliability (in Study 1a:  $\alpha_{\text{Novelty}}=.91$ ,  $\alpha_{\text{Augmentation}}=.71$ ; in Study 1b:  $\alpha_{\text{Novelty}}=.89$ ,  $\alpha_{\text{Augmentation}}=.64$ ). For the factor structure, see Table 1; for correlations between variables, see Table 2).

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<sup>3</sup> Data collection for Study 1a was part of a larger project on creativity, and the creativity variables have previously been analyzed as part of a project looking at the association between creativity and specific mindfulness skills (Baas, Nevicka, & Ten Velden, 2014; Study 2). In that past work, neither the novelty seeking nor the openness to experience data were analyzed, so the relations of those variables with creativity reported herein are entirely novel. Other measures in this study focused on creative achievement across various domains (Carson et al., 2005). These measures were not central to our investigation; details and results with these measures may be obtained from the first author.

**Openness and Extraversion.** The Big Five personality factors extraversion and openness to experience were assessed using the Dutch 5PFT (Elshout & Akkerman, 1975). The test has 70 items (14 per factor), and each item consists of a short description (e.g., “Cultured. Reads a lot and has broad intellectual and cultural interests.”), with participants indicating on a seven-point scale how well it describes them (1 = “not at all” to 7 = “very much”). Reliabilities for our two independent variables were good (Study 1a:  $\alpha_{\text{Openness}}=.79$ ,  $\alpha_{\text{Extraversion}}=.86$ ; Study 1b:  $\alpha_{\text{Openness}}=.83$ ,  $\alpha_{\text{Extraversion}}=.87$ ); for correlations with other measures, see Table 2.

**Divergent Thinking.** Divergent thinking was assessed with two alternative uses tasks (Guilford, 1950; Torrance, 1974). Participants were asked to come up with as many uses for a “cable” and “tin can” as possible, each within two minutes (Baas, Nevicka, & Ten Velden, 2014; Gocłowska & Crisp, 2013). The computer screen showed an input box to type ideas in, one at a time. In total, participants generated 1,465 (Study 1a) and 2,999 (Study 1b) non-redundant ideas for the cable and 1,560 (Study 1a) and 2,822 (Study 1b) non-redundant ideas for the tin can. For all measures -- fluency, flexibility, infrequency, and subjective originality -- average scores were computed across the two tasks. Participants’ responses were counted and rated by an expert coder. The correlations between the different indices of divergent thinking are presented in Table 3.

*Fluency* (Study 1a:  $M=6.75$ ,  $SD=2.65$ ; Study 1b:  $M=7.12$ ,  $SD=3.04$ ) was computed as the mean number of non-redundant ideas generated by participants. *Flexibility* (Study 1a:  $M=4.43$ ,  $SD=1.47$ ; Study 1b:  $M=3.39$ ,  $SD=1.14$ ) was measured by counting the number of different semantic categories used by participants (Nijstad, De Dreu, Rietzschel, & Baas, 2010). Using a preexisting coding scheme (Baas et al., 2014), a trained rater (blind to the purpose of the study) classified all non-redundant ideas into one of several distinct semantic categories. For example,

for the cable, the ideas “jumping rope”, “kite rope” and “limbo dancing rope” would be coded in the category “sports and play”, and for the tin can, the ideas “pencil box”, “sugar pot” and “money box”, would be coded into the category “container”. To obtain an inter-rater reliability assessment, a second coder rated 120 ideas from Study 1a. Inter-rater reliability for both topics was good (Cohen’s  $Ks > .96$ ,  $ps < .001$ ). Since the same coder coded ideas from both studies using an identical coding scheme, inter-rater reliability was computed only once.

A relative *infrequency* score (Study 1a:  $M = .86$ ,  $SD = .05$ ; Study 1b:  $M = .86$ ,  $SD = .05$ ) was computed by checking how often participants’ ideas were mentioned by the whole sample (Baas et al., 2014). If ideas were mentioned by a small number of other participants, the infrequency score would be high; if ideas were mentioned by a large number of other participants, the infrequency score would be low. The score for each idea was computed as 100 minus the portion of the sample mentioning the particular idea. This resulted in a range from 0 to 100, where scores closer to 0 indicated ideas that were less original (more frequent) and scores closer to 100 indicated ideas that were more original (more infrequent). The relative infrequency score was the average infrequency score across all of one’s ideas (Baas et al., 2014; Gocłowska & Crisp, 2013).

Finally, to generate an indicator of *subjective originality* (Study 1a:  $M = 2.03$ ,  $SD = 0.28$ ; Study 1b:  $M = 1.93$ ,  $SD = 0.29$ ), the same trained rater coded all ideas on a 5-point scale (1=“not at all original”; 5=“very original”). A second trained rater coded 120 of the ideas (8%) for each topic; inter-rater agreement for both topics was good (ICCs  $> .86$ ,  $ps < .001$ ).

After coding the divergent thinking measures, we ran standard (*a priori*) checks for violation of the normality assumption. Univariate outliers are cases with extreme scores on a single variable, and multivariate outliers are cases of extreme relations between variables. In

accord with recommendations (Field, 2013), univariate outliers (scores with absolute value higher than  $3SD$  from  $M$ ) were winsorized (i.e., capped to the exact value of  $\pm 3SD$  from  $M$ ), and where skewness was identified, the scores were transformed to return their distribution to a near-normal distribution. In Study 1a fluency was skewed, and in Study 1b fluency, flexibility, and subjective originality were skewed ( $|SE\ Skew| < 2 * Skewness\ Statistic$ ), and this was corrected by applying a square root transformation (for similar procedures, see Gocłowska, Baas, Crisp, & De Dreu, 2014). The analyses are based on these transformed data. In addition, in both Study 1a and 1b two multivariate outliers were detected ( $>3SD$  from the regression line in the relation between novelty seeking and divergent thinking); these outliers had a substantial influence on the data (Cook's distance  $D > 4/n$ ) and they were dropped from the main analyses in line with recommendations (Draper & John, 1981; Gocłowska, Baas, Elliot, & De Dreu, 2017).

To obtain a *total divergent thinking score* (Study 1a:  $M=0.00$ ,  $SD=0.74$ ; Study 1b:  $M=0.00$ ,  $SD=0.75$ ), we averaged the corrected and standardized  $z$  scores for the four indices of divergent thinking (fluency, flexibility, infrequency, and originality; Study 1a:  $\alpha=.73$  and Study 1b:  $\alpha=.75$ ). Correlations of raw scores and the final total divergent thinking score are presented in Table 3.

## Results

The data were analyzed using regression analyses in Mplus version 7 (Muthen & Muthen, 1998-2011). For clarity of presentation we ran our analyses with the total divergent thinking score as the main outcome variable. With regard to Study 1a and 1b we hypothesized that openness to experience and extraversion would emerge as simultaneous predictors of novelty seeking, and that novelty seeking would predict divergent thinking performance. In additional ancillary analyses we tested whether novelty seeking mediates the link between openness and extraversion on the one side, and divergent thinking on the other.

### Regression analyses

To test our hypotheses, we ran a series of regression analyses in which novelty seeking was (simultaneously) predicted from openness and extraversion (Model 1), divergent thinking was predicted from novelty seeking (Model 2), and divergent thinking was predicted from novelty seeking, extraversion, and openness (Model 3). In support of Hypothesis 1 in Model 1, both extraversion (Study1a:  $b=.25$ ,  $SE=.05$ ,  $p<.001$ ; Study1b:  $b=.18$ ,  $SE=.03$ ,  $p<.001$ ) and openness (Study1a:  $b=.29$ ,  $SE=.06$ ,  $p<.001$ ; Study1b:  $b=.22$ ,  $SE=.04$ ,  $p<.001$ ) emerged as significant *simultaneous* predictors of novelty seeking. In support of Hypothesis 2 in Model 2, novelty seeking significantly predicted divergent thinking (Study1a:  $b=.31$ ,  $SE=.07$ ,  $p<.001$ ; Study1b:  $b=.23$ ,  $SE=.07$ ,  $p=.001$ ). In Model 3 where extraversion, openness, and novelty seeking were entered as simultaneous predictors of divergent thinking, extraversion did not emerge as a significant predictor (Study1a:  $b=-.06$ ,  $SE=.07$ ,  $p=.383$ ; Study1b:  $b=.07$ ,  $SE=.05$ ,  $p=.109$ ), openness emerged as a significant predictor (Study1a:  $b=.20$ ,  $SE=.08$ ,  $p=.008$ ; Study1b:  $b=.16$ ,  $SE=.06$ ,  $p=.002$ ), while the effect of novelty seeking was significant in Study 1a ( $b=.25$ ,  $SE=.09$ ,  $p=.007$ ) and insignificant in Study 1b ( $b=.13$ ,  $SE=.08$ ,  $p=.096$ ).

In ancillary analyses we ran bootstrapping analyses testing whether novelty seeking mediated the effect of openness on creativity and of extraversion on creativity. A significant mediation pattern was uncovered only in models with a single predictor (extraversion *or* openness), but when extraversion and openness were entered as simultaneous predictors, the mediation pattern was not consistent (mediation was uncovered in Study 1a but not in Study 1b). Given these uncertainties, and the fact that one cannot infer causality from the present set of data, we decided not to report the full mediation analyses in the paper.

### Study 2



Study 1a and 1b demonstrated that novelty seeking is linked with openness and extraversion as well as with divergent thinking. However, the correlational design of the studies prohibits causality statements; in particular, it remains unclear whether novelty seeking directly leads to more creativity. To answer this question, in Study 2 we investigated whether inducing novelty seeking can boost divergent thinking. That certain trait constructs can be manipulated in state form has been demonstrated, for instance in research on extraversion (Fleeson, Malanos, & Achille, 2002), suggesting that a similar principle could operate for novelty seeking. Demonstrating that *state* novelty seeking *causes* divergent thinking would have the additional benefit (over and above demonstrating causality) of identifying a way to increase people's divergent thinking.

### **Participants.**

One hundred and forty-seven Dutch participants (75% females,  $M_{age}=27$ ) completed the experiment<sup>4</sup>. A diverse sample was recruited via the Radboud University Nijmegen research participation structure (61% rewarded with course credit;  $M_{age}=19.43$ ), social media, and email invitations sent out by research assistants (39% received no reward;  $M_{age}=39.09$ ). Participants were told that the experiment focused on language comprehension. Eight individuals who took an extremely long time to complete the experiment (234 - 937 min.) were omitted from the data set *a priori*. The remaining 139 participants took, on average, 23 minutes to complete the experiment.

### **Design and Procedure.**

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<sup>4</sup> To be able to detect a medium size effect ( $\eta=.06$  equivalent to  $d=.50$ ) with the power of .80 in a 3-level between subjects design requires an  $N=159$  (Faul et al., 2009). We sought to recruit as large of a sample size as we could given the time and participant availability constraint that we faced. These constraints led us to acquire a somewhat less smaller sample size than would be optimal:  $N=147$ .

Participants completed the experiment online; instructions were provided via the Qualtrics platform. First, participants signed a consent form, and then they were randomly assigned to one of three experimental conditions: baseline control, novelty control, and novelty seeking. In the *baseline control* condition ( $N=48$ ) there was no manipulation, and the questionnaire automatically advanced to the divergent thinking measures and manipulation checks. In the *novelty control* condition ( $N=50$ ) participants read a fictitious news article discussing the benefits and drawbacks of experiencing novelty in one's life. In the article, two people argued for the benefits, and two argued for the drawbacks of having a lot of novelty in ones' life. There were 10 gaps in the article, and participants were asked to fill in those gaps with 10 novelty-related words (e.g., new, change, diversity) from a list provided above the article. To ensure neutrality, the article discussed both positive and negative aspects of novelty to the same extent. In the *novelty seeking* condition ( $N=49$ ) participants completed the same gap-filling task, but then were additionally asked to describe two ways in which novelty could benefit them in the future. Considering the benefits of novelty in the context of one's own life, we hoped, would evoke a greater motivation to seek novelty in the research participants.

Following the manipulation, participants completed a divergent thinking task in which they generated multiple uses for a brick and, to gauge the effects of the manipulation, they answered questions about their motivation to seek out novel experiences.<sup>5</sup> We predicted that the novelty seeking manipulation would lead to greater divergent thinking, relative to the two control conditions.

### **Measures.**

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<sup>5</sup> Participants also completed a measure of behavioral approach and avoidance and, following the manipulation, a gap filling exercise, and 29 mood-related items. Details on these variables may be obtained from the first author.

**Divergent Thinking.** Divergent thinking was assessed with the most popular variant of the alternative uses task – the brick task (e.g., Ritter et al., 2012). Participants were given three minutes to generate as many different uses for a brick as they could. To assess *fluency* ( $M=8.13$ ,  $SD=3.59$ ), a trained coder, blind to the hypothesis, counted the number of ideas generated by participants. To assess *flexibility* ( $M=5.66$ ,  $SD=2.21$ ), the same rater assigned each idea to one of 38 semantic categories, based on a previously established coding scheme (Gocłowska & Crisp, 2013). For example, an idea to use bricks as large dominoes would be categorized as “game” and an idea to build a table with it would be categorized as “furniture”. Relative *infrequency* ( $M=0.91$ ,  $SD=0.04$ ) was computed with regard to how often a given category was mentioned by the whole sample. If the category was mentioned by a small number of other participants in the sample, the infrequency score would be high; if the category was mentioned by a large number of participants in the sample, the infrequency score would be low. The score for each category was computed as: 100 minus the portion of the sample mentioning the category, resulting in a range from 0 to 100, where scores closer to 0 indicated categories that were less original (more frequent) and scores closer to 100 indicated categories that were more original (more infrequent). The mean infrequency score of each participant’s full set of categories was used as the infrequency indicator (Baas et al., 2014; Gocłowska & Crisp, 2013).

To assess subjective *originality* ( $M=2.87$ ,  $SD=0.63$ ; 1 = “not at all original”; 5 = “very original”) participants’ ideas were rated by two trained coders, and we computed the mean of their originality ratings ( $ICC=.93$ ,  $p<.001$ ). At the end of the study we assessed participants’ gender, age, education level, nationality, Dutch proficiency, and their additional thoughts about the experiment (if any). There was also a box where participants could provide additional

comments about difficulties experienced during the study, and where they could guess the focus of the study.

We used the same method for addressing outliers used in Studies 1 and 2. Fluency was positively, and infrequency was negatively skewed ( $|SE\ Skew| < 2 * Skewness\ Statistic$ ), and these were corrected by applying a square root transformation (infrequency was additionally reversed and back-reversed post transformation, given the sign of the skew). The analyses are based on these transformed data.

As in Studies 1a and 1b, we computed a total divergent thinking score by averaging the corrected and standardized scores of the four indices of divergent thinking ( $\alpha = .60$ ). Given the modest reliability of the total divergent thinking score, we first analyzed the data in line with the general prediction, that novelty seeking should increase divergent thinking, and then explored the data further by looking at the individual divergent thinking indices as a within-subjects factor. This would allow us to test for the main effect of the manipulation on mean levels of divergent thinking, but would also highlight any differences in how the four indices of divergent thinking were affected by the manipulation.

**Manipulation Check.** At the end of the experiment (following the divergent thinking measures) participants were asked about the extent to which they were motivated to seek out novelty (“At the moment I am motivated to reach new things.” and “At this moment I am motivated to discover new things.”,  $r = .51$ ,  $p < .001$ ).

## **Results.**

**Manipulation Checks.** Participants completed the gap-filling task nearly perfectly (99% correct responses), and there were no significant differences in response rates between the novelty and novelty seeking condition:  $F(1,91) = 1.24$ ,  $p = .237$ . In the novelty seeking condition

96% of participants typed at least two reasons why novelty can improve their life (e.g., “Keeps you sharp and motivated”, “Broadens your basis, makes you stronger through learning from a different environment”). To test whether the manipulation elicited greater novelty seeking relative to the two control conditions, we conducted a one-way ANOVA with our manipulation as a 3-level between-subjects factor, and state novelty seeking as the dependent variable. This revealed a marginal omnibus effect of the manipulation of novelty seeking  $F(2,136)=2.82$ ,  $p=.063$ ,  $\eta^2=.04$ . Our specific expectation was that participants’ state motivation to seek novelty would be higher in the novelty seeking condition, relative to the two control conditions. This could be tested using planned contrasts that compare every next condition against the prior conditions (also known as “Reverse Helmert Contrasts”; Field, 2013; Tiedens, Unzueta, & Young, 2007). The first contrast (-1,1,0), comparing the novelty control control ( $M_{NC}=5.01$ ,  $SD_{NC}=1.02$ ) to the baseline control ( $M_{BC}= 5.22$ ,  $SD_{BC} =1.11$ ) condition, revealed no significant difference ( $p=.316$ ). The second contrast (-1,-1,2), comparing the novelty seeking condition ( $M_{NS}=5.50$ ,  $SD_{NS}=0.83$ ) against the two control conditions, revealed a significant difference ( $p=.034$ ).<sup>6</sup> This suggests that the novelty seeking condition (vs. the two control conditions) was a successful manipulation of state novelty seeking.

**Divergent Thinking.** To test our *a priori* hypothesis about the effect of novelty seeking on creativity we ran a One-way ANOVA with the manipulation as a between-subjects factor, and the total divergent thinking score as a dependent variable. Additionally, because the total divergent thinking score had only modest reliability, we also ran a *post-hoc* Mixed-Model ANOVA, with the manipulation entered as a between-subjects factor, and the individual

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<sup>6</sup> We also ran a planned simple contrast (comparing every condition to the last). This revealed no significant difference between the baseline control vs. novelty seeking condition ( $p=.188$ ), but a significant difference between the novelty control and the novelty seeking condition ( $p=.006$ ).

divergent thinking indices (z-scored fluency, flexibility, infrequency and subjective originality) as a within-subjects factor. This additional analysis would allow us to explore any differences that may arise in how the four indices of divergent thinking were affected by the manipulation.

***A priori hypothesis test.*** A One-way ANOVA with condition as the between-subjects factor, and the total divergent thinking score as the dependent variable, revealed the predicted main effect of condition:  $F(2,133)=6.38, p=.002, \eta^2=.09$ . The first contrast (-1,1,0), comparing the novelty control condition ( $M_{NC}=-0.06, SD_{NC}=0.72$ ) to the baseline control condition ( $M_{BC}=-0.19, SD_{BC}=0.68$ ) revealed no significant difference ( $p=.358$ ). The second contrast (-1,-1,2), comparing the novelty seeking condition ( $M_{NS}=0.29, SD_{NS}=0.54$ ) against the two control conditions revealed a significant difference ( $p=.001$ ).<sup>7</sup> This result is illustrated in Figure 1, upper panel, where the mean score of divergent thinking is higher in the novelty seeking condition, compared to the two control conditions.

***Post hoc analyses.*** A 3(condition) x 4(z-scored fluency, flexibility, infrequency and subjective originality) mixed model ANOVA revealed a main effect of condition identical to the *a priori* analysis:  $F(2,133)=6.38, p=.002, \eta^2=.09$  (see previous section). This effect was additionally qualified by an interaction term with the within-subjects factor:  $F(6,399)=2.76, p=.012, \eta^2=.04$ , suggesting that the effect of the manipulation differed across the four divergent thinking indices.

To break down this interaction, we ran difference contrasts separately for each dependent variable (see middle and bottom panel in Figure 1). The first contrast (-1,1,0) revealed no significant differences between the novelty vs. control condition for three out of four indices of

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<sup>7</sup> We also ran a planned simple contrast (comparing every condition to the last). This revealed a significant difference between the control vs. novelty seeking condition ( $p=.001$ ), as well as between the novelty control compared to the novelty seeking condition ( $p=.011$ ).

divergent thinking. Namely, flexibility ( $M_{NC}=0.00$ ,  $SD_{NC}=0.93$  vs.  $M_{BC}= -0.33$ ,  $SD_{BC} =0.94$ ), infrequency ( $M_{NC}=-0.12$ ,  $SD_{NC}=1.10$  vs.  $M_{BC}= -0.18$ ,  $SD_{BC} =0.99$ ), and originality ( $M_{BC}=0.06$ ,  $SD_{NC}=1.16$  vs.  $M_{NC}= -0.32$ ,  $SD_{BC} =0.92$ ) were not significantly different between the two control conditions ( $p_{flexibility}=.099$ ,  $p_{infrequency}=.768$ ,  $p_{originality}=.066$ ). A significant effect for fluency ( $p_{fluency}=.017$ ) revealed that in the novelty control condition participants generated more ideas ( $M_{NC}=0.97$ ,  $SD_{NC}=0.14$ ) than those in the baseline control condition ( $M_{BC}= -0.29$ ,  $SD_{BC} =0.99$ ).

For the contrast between novelty seeking vs. the two control conditions, a significant effect emerged for flexibility ( $M_{NS}=0.38$ ,  $SD_{NS}=1.05$ ,  $p_{flexibility}=.003$ ), infrequency ( $M_{NS}=0.31$ ,  $SD_{NS}=0.85$ ,  $p_{infrequency}=.013$ ), and originality ( $M_{NS}=0.32$ ,  $SD_{NS}=0.84$ ,  $p_{originality}=.014$ ). For fluency, the novelty seeking condition ( $M_{NS}=0.21$ ,  $SD_{NS}=0.97$ ) was not significantly different from the other two conditions ( $p_{fluency}=.141$ ).<sup>8</sup> This means that the novelty seeking manipulation increased divergent thinking (relative to the two control conditions) especially in terms of idea flexibility, infrequency and originality, but not in terms of the number of ideas generated.

### General Discussion

Creativity is valued in education (Robinson, 2001), business (Lombardo & Roddy, 2010), and the arts (Feist, 1998), and much effort and money is spent every year in order to develop the creativity of individuals and groups. While a lot is known about what personality traits support creative thought, we know relatively little about more concrete behavioral tendencies that support greater creative generation. To address this question we looked at novelty seeking, and

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<sup>8</sup> Additional planned simple contrasts revealed significant differences between the baseline control vs. novelty seeking condition for three out of four indices of divergent thinking ( $p_{fluency}=.028$ ,  $p_{flexibility}=.001$ ,  $p_{infrequency}=.022$  and  $p_{originality}=.216$ , respectively). For the contrast between novelty control vs. novelty seeking, a significant effect emerged on two out of four dependent measures ( $p_{fluency}=.906$ ,  $p_{flexibility}=.070$ ,  $p_{infrequency}=.041$  and  $p_{originality}=.002$ , respectively).

asked whether this tendency is linked to greater extraversion and openness (Study 1a and Study 1b), and whether it is linked to (Study 1a and Study 1b), and can lead to (Study 2) greater divergent thinking performance. Consistent with our predictions, in Studies 1a and 1b novelty seeking was linked to greater divergent thinking and to two core personality traits that are the strongest predictors of creativity – openness to experience and extraversion. In Study 2 we experimentally increased participants’ motivation to seek novel things, and demonstrated that this manipulation increased divergent thinking performance.

### **Theoretical Contributions**

These findings have important implications for creativity research. They demonstrate that the personality traits of extraversion and openness, as well as actual divergent thinking, are linked to a greater tendency to seek novel stimuli. The link between novelty seeking and the two personality traits is of medium-to-large magnitude and seems quite robust. The link between novelty seeking and divergent thinking is of small-to-medium magnitude and seems quite robust as well; more importantly, as we demonstrated in Study 2, the link between *state* novelty seeking and creativity is causal in nature. This suggests that a greater degree of novelty seeking does not merely associate with, but can also *enhance* divergent thinking, and that increasing novelty-seeking tendencies may contribute to developing greater creativity in individuals and groups. Whether this conclusion could also be applied to *trait* novelty seeking could be examined in longitudinal studies (using cross-lagged panel analysis; Kenny, 1979) testing whether increases in trait novelty seeking result in greater creative performance in the longer term.

In addition, the fact that novelty seeking is related to individual differences in extraversion and openness to experience on the one hand, and divergent thinking, on the other, suggests that the seeking of, and engagement in, novelty seeking behaviors could be the



underlying mechanism behind the personality–creativity link. However, while these results can be *suggestive* of mediation, we have not found clear evidence for this in our analyses, especially in analyses where openness and extraversion were entered as simultaneous predictors.

Additionally, from the current cross-sectional studies we cannot infer whether openness and extraversion actually *cause* novelty seeking. To truly test causality in this case would require manipulating openness and extraversion, or examining their fluctuations over time, and examining whether changes in the level of those traits result in subsequent alterations in novelty seeking.

Our study also contributes to the literature on novelty seeking in several important ways. First, by linking novelty seeking to positive, adaptive outcomes, our study pushed the boundaries of novelty seeking research. Novelty seeking is widely researched in clinical psychology, where the focus is mostly on its negative outcomes, including substance abuse (Krebs et al., 1998), eating disorders (Bulik et al., 1995), and various antisocial behaviors (Hesselbrock & Hesselbrock, 1992). We demonstrated that there can also be upsides to being a novelty seeking individual. As we have shown, this occurs because increased novelty seeking leads to greater creativity. In addition (but unexplored in the present investigation) novelty seeking may also push people to undergo novel and unusual experiences (e.g., diversifying experiences; Damian & Simonton, 2014; Gocłowska, Damian, & Mor, 2017; Ritter et al., 2012), further increasing their creative potential. Secondly, by showing that novelty seeking can be evoked via manipulation, our study paints novelty seeking in a novel light – as a malleable behavioral tendency. This perspective on novelty seeking, while extending the boundaries of prior research on the topic, is in general agreement with findings showing that the extent of people’s novelty seeking is a function of both genetics and environment (Bardo, Donohew, & Harrington, 1996).

### Limitations

Our research has some shortcomings. While the studies did a nice job of demonstrating a link between novelty seeking and divergent idea generation, research has yet to confirm whether such benefits to divergent thinking will carry-over to real life creativity outcomes. In partial support of this idea, in ancillary analyses of Study 1b<sup>9</sup> the extent to which people have displayed recognized creative achievements in several domains (assessed with the Creative Achievements Questionnaire; Carson, Peterson, & Higgins, 2005) was positively associated with novelty seeking. However, the same relation was not significant in Study 1a, making the results inconsistent. Future studies with a highly powered design may establish that link more profoundly.

Whether novelty seeking should be linked with creative achievement is not entirely clear, because flexibility and the generation of novel ideas are not always sufficient for creative success. According to classical theorizing, to be considered creative, ideas need not just be *novel*, they also need to have a degree of *usefulness* (Amabile, 1983), creators need not just be flexible, but also persistent (Nijstad et al., 2010), and once ideas are generated, they need to be subsequently elaborated on, promoted, and implemented (Perry-Smith & Mannucci, 2017). Taken together, it's quite possible that novelty seeking will lead to greater creative achievement when it is coupled with a goal-oriented and persistent approach to one's creative goals.

Finally, Study 2 was somewhat underpowered. Future research is needed to test and, ideally, extend the focal relations with a more sizeable sample.

### Future Research

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<sup>9</sup> The link between Creative Achievement and novelty seeking was  $r_{NS} = .03$ ,  $p = .663$  in Study 1a, and  $r_{NS} = .12$ ,  $p < .007$  in Study 1b.

While many groups and organizations explicitly value creativity, this does not always carry over to the actual selection of creative ideas. Novel ideas and solutions are uncertain, and can often face backlash and be rejected in the idea selection process (Karwowski, 2010; Mueller, Melwani, & Goncalo, 2012; Rietzschel, Nijstad, & Stroebe, 2010). One important direction for future research is to examine the question of whether fostering greater novelty seeking in individuals and organizations can help promote good, innovative ideas and problem solutions. Also, in more general terms, for many years psychologists have deliberated on the various ways to reduce bias against people and ideas that deviate from the norm and challenge stereotypes (Gocłowska, Baas, et al., 2017). Novelty seeking may constitute an important antidote to these problems, and encourage people to gain more information before rejecting targets that do not “fit the mold”. Future studies would do well to test these ideas, for instance, by looking at the effects of novelty seeking on the inclusion and rejection of unusual ideas, and individuals who promote such ideas.

### **Summary**

Our research set out to find whether trait and state novelty seeking are linked to divergent thinking, and we found clear support for this relation. First, we found that novelty seeking is linked to the creativity-related traits openness to experience and extraversion, and to creative performance itself. Second, we found that a manipulation of novelty seeking has the potential to enhance divergent thinking. We hope that these findings will help extend the current understanding of creativity and novelty seeking processes, and that they will inspire practitioners in developing psychological interventions aimed at increasing creative idea generation and selection.

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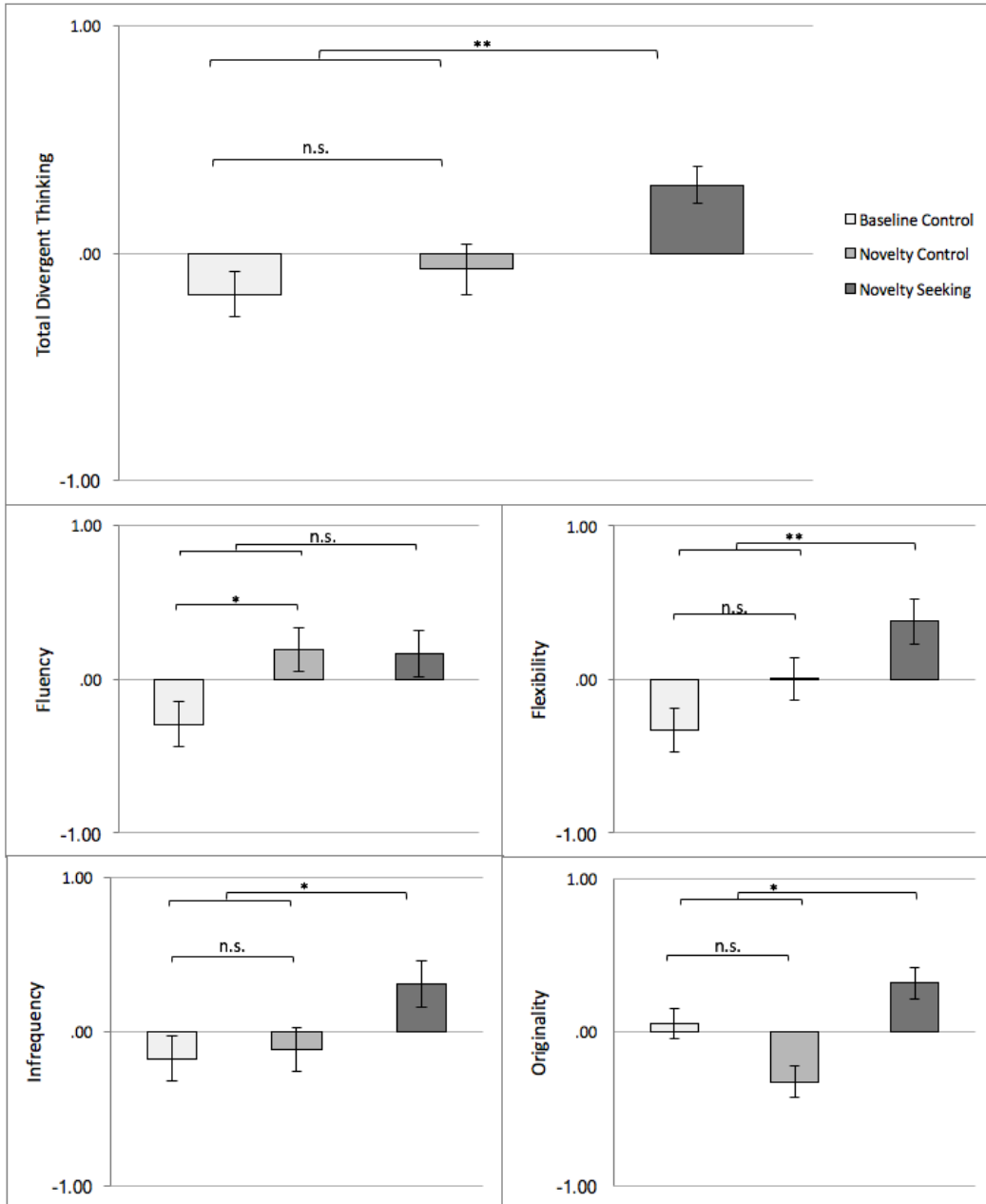
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*Figure 1.* The top panel represents the total divergent thinking score in Study 2. Total divergent thinking was higher in the novelty *seeking* condition relative to the (combined) control and novelty condition (top contrast), and no significant difference emerged between the novelty condition and control condition (bottom contrast). The middle and bottom panels represent the same data, broken down by the four individual indices of divergent thinking. Fluency was higher in the novelty vs. control condition (bottom contrast). Flexibility, infrequency and originality were higher in the novelty *seeking* condition vs. the (combined) control and novelty condition (top contrast), but they were not significantly different between the novelty condition and the control condition (bottom contrast). Scores represent standardized z-scores, error bars represent Standard Error of the Mean; \* $p < .05$ , \*\* $p < .01$ .

	Pretest		Study 1a		Study 1b	
	NS	A	NS	A	NS	A
1 I usually seek out new opportunities or experiences. <sup>a</sup>	<b>.80</b>	.06	<b>.81</b>	-.08	<b>.63</b>	.30
2 I prefer change to routine. <sup>b</sup>	<b>.79</b>	.09	<b>.67</b>	.04	<b>.70</b>	-.08
3 I seek adventure. <sup>b</sup>	<b>.74</b>	.06	<b>.80</b>	.06	<b>.70</b>	-.01
4 I am always interested in finding new things to try. <sup>a</sup>	<b>.71</b>	.07	<b>.76</b>	.01	<b>.74</b>	.17
5 I dislike change. <sup>b</sup> (r)	<b>-.64</b>	.15	<b>-.65</b>	.20	<b>-.65</b>	.05
6 I love to think up new ways of doing things. <sup>b</sup>	<b>.70</b>	.06	<b>.60</b>	-.08	<b>.56</b>	.21
7 I place a lot of importance on experiencing new things. <sup>a</sup>	<b>.69</b>	.03	<b>.72</b>	-.01	<b>.71</b>	.25
8 I prefer to stick with things that I know. (r) <sup>b</sup>	<b>-.66</b>	.01	<b>-.56</b>	.03	<b>-.69</b>	.01
9 I like to begin new things. <sup>b</sup>	<b>.67</b>	-.14	<b>.78</b>	-.08	<b>.67</b>	.25
10 I am open to change. <sup>b</sup>	<b>.64</b>	-.12	<b>.79</b>	-.06	<b>.70</b>	.12
11 Trying new things is important for me to stay happy. <sup>a</sup>	<b>.64</b>	.20	<b>.67</b>	.10	<b>.69</b>	.06
12 I generally prefer to have more familiarity and stability. <sup>a</sup> (r)	<b>-.52</b>	.06	-.31	.20	<b>-.52</b>	.16
13 I enjoy hearing new ideas. <sup>b</sup>	<b>.60</b>	-.10	<b>.72</b>	-.02	<b>.58</b>	.31
14 I like to visit new places. <sup>b</sup>	<b>.55</b>	-.02	<b>.58</b>	-.08	.36	.33
15 Trying to learn more about something I already understand is usually not worth the effort. <sup>a</sup>	-.11	<b>.83</b>	.03	<b>.84</b>	-.06	<b>.75</b>
16 There are better ways to spend my time than trying to learn more about something I basically understand. <sup>a</sup> (r)	.06	<b>.83</b>	.01	<b>.69</b>	.06	<b>.46</b>
17 Exploring something in depth is usually pretty tedious and boring. <sup>a</sup> (r)	-.15	<b>.78</b>	-.10	<b>.74</b>	-.16	<b>.57</b>
18 Once I have a basic understanding of something, I do not feel it is necessary to learn more about it. <sup>a</sup> (r)	-.04	<b>.75</b>	.01	<b>.75</b>	-.07	<b>.65</b>
19 I enjoy gaining a more thorough understanding of something I already know. <sup>a</sup>	-.16	<b>-.59</b>	.26	-.24	.05	<b>-.62</b>
Eigenvalue	6.33	3.02	6.68	2.45	6.21	2.06
Variance Explained	33%	16%	35%	13%	33%	11%

Note: <sup>a</sup> = Item of the Personal Expansion Questionnaire; <sup>b</sup> = Item from the International Item Pool; NS = Novelty Seeking; A = Augmentation.

Bolded items represent factor loadings > .45. Following the pre-test, three novelty seeking items, and one augmentation item were dropped. Some items have also been slightly rephrased, and the table represents the final version of these items. In Studies 1a and 1b the items used were identical.

Table 1. Loadings on the novelty seeking and augmentation factors.

Table 2. Correlations between key variables in Studies 1a and 1b.

	Study 1a/Study 1b						
	$\alpha$	$M$	$SD$	1	2	3	4
1 Novelty Seeking	.91/.89	3.70/3.78	.59/.56				
2 Augmentation	.71/.64	3.49/3.39	.64/.61	.16*/.24**			
3 Openness	.79/.83	4.61/4.69	.67/.73	.45**/.35**	.37**/.36**		
4 Extraversion	.86/.87	4.42/4.53	.80/.86	.45**/.34**	.10/-.05	.34**/.19**	
5 TDT	.73/.75	.00/.01	.74/.75	.23**/.18**	.08/.00	.24**/.21**	.08/.15**

Note: \*  $p < .05$ , \*\*  $p < .01$ ;  $\alpha$  = Cronbach's alpha; TDT = Total Divergent Thinking; Openness = Openness to Experience.

Table 3. Correlations between raw scores of the divergent thinking indices, and the total divergent thinking score (Studies 1-2).

	<i>M</i>	<i>SD</i>	Study 1a/Study 1b/Study 2			
			1	2	3	4
1 Fluency	6.75/7.12/8.13	2.65/3.04/3.59				
2 Flexibility	4.43/3.39/5.66	1.47/1.14/2.21	.81**/.69**/.41**			
3 Infrequency	.86/.86/.91	.05/.05/.04	.25**/.32**/.00	.25**/.31**/.40**		
4 Originality	2.03/1.93/2.87	.28/.29/.63	.20**/.29**/-.03	.22**/.30**/.27**	.65**/.57**/.69**	
5 TDT	.00/.01/.01	.74/.75/2.68	.76**/.77**/.49**	.77**/.78**/.74**	.72**/.72**/.78**	.70**/.72**/.71**

Note: \*  $p < .05$ , \*\*  $p < .01$  (2-tailed); TDT = Total Divergent Thinking. Scores for Studies 1a & 1b were derived from participants' ideas on how to use a tin can and a string. Scores for Study 2 were derived from participants' ideas on how to use a brick.



*Table 4.* Analyses for Study 1a (top row) and Study 1b (bottom row) regressing novelty seeking on openness and extraversion (Model 1), divergent thinking on novelty seeking (Model 2) and divergent thinking on extraversion, openness and novelty seeking (Model 3).

Study 1a									
	Novelty Seeking			Divergent Thinking					
	Model 1			Model 2			Model 3		
	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>
Extraversion	.25	.05	.00	-	-	-	-.06	.07	.38
Openness	.29	.06	.00	-	-	-	.20	.08	.01
Novelty Seeking	-	-	-	.31	.07	.00	.25	.09	.01
Study 1b									
	Novelty Seeking			Divergent Thinking					
	Model 1			Model 2			Model 3		
	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>
Extraversion	.18	.03	.00	-	-	-	.07	.05	.11
Openness	.22	.04	.00	-	-	-	.16	.06	.00
Novelty Seeking	-	-	-	.23	.07	.00	.13	.08	.10

*Note:* In support of hypothesized relations extraversion and openness were simultaneous predictors of novelty seeking (Model 1), and novelty seeking predicted divergent thinking (Model 2).