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Possibility Thinking Scale: An initial psychometric exploration

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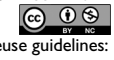

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Abstract

Although there has been longstanding work on possibility thinking (PT), there is no current scale that researchers can use to measure and study this important action-based orientation. In this paper, we report on four studies with English and Polish speaking participants ($N > 1{,}500$) focused on developing and providing an initial evaluation of the Possibility Thinking Scale (PTS). Across the four studies, we examined the factor structure of the PTS by comparing one- and three-factor models and tested the links between PT and relevant correlates: divergent thinking, creative agency factors, and facets of Openness and Extraversion. After a series of replications presented in Studies 1 to 3, Study 4 ($N = 491$) explored revisions to the scale, using new items developed with input from Large Language Models. Taken together, our results indicate that the final version of PTS reflects three factors of one's orientation to the possible (i.e. awareness, excitement, and exploration). Our results also indicate that the factors were associated with, but sufficiently distinct from related constructs. We close by discussing strengths and weaknesses of PTS and propose future directions for research.

Keywords

Creative agency, creativity, divergent thinking, possibility thinking, Possibility Thinking Scale

Possibility Thinking (PT) represents an orientation toward what "could be," "could have been," "will be," and "can never be." It is a core aspect of purposeful human action as it unfolds across past, present, and future. The origins of PT are often associated with the pioneering work of Anna Craft and her collaborators in educational contexts (see Craft, 2015). Craft and her colleagues viewed PT as occurring in the relational space between teachers and learners and as a form of thinking-in-action; these

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actions include posing questions, playing, being immersed, innovating, risk-taking, being imaginative, and enjoying self-determination (Burnard et al., 2006; Chappell et al., 2008). Another point of focus in these initial conceptualizations was the development and implementation of pedagogies that foster PT (Cremin et al., 2006), orienting researchers toward the idea that this is a disposition that can be nurtured and scaffolded. Some concrete activities in this regard included engaging in individual, collaborative, and communal play, using leading questions, and imagining as well as narrating with adults (Craft et al., 2012).

From theory to practice, these early explorations into PT firmly established it as irreducible to a single cognitive style. In fact, to engage in PT means to think but also to feel, act, and relate to others and a particular context. The "thinking" is enacted, extended, expanded, and distributed into the world. PT is thereby best conceptualized as an action-based orientation toward the possible in our own existence and in the existence of others, both situated within a shared social, material, and cultural world.

This focus has remained in more recent elaborations on PT. Beghetto (2018), for instance, developed a Possibility Thinking Protocol, which has two parts: (1) generating possibilities and (2) anticipating and proactively addressing setbacks. More recently, he has developed additional possibility thinking heuristics and bots,[1] which extend the process of PT through Human × Human and Human × AI interactions (see Beghetto, 2023a, 2023b). Other contemporary elaborations include Glăveanu's work (2023a), which describes PT as a form of thinking wide (i.e. "what could be?"), compared to thinking narrow (i.e. "what is?"). These elaborations maintain the view of a more expansive or sociocultural creative process rather than a process limited to individual cognition (see also Ross, 2023). In this way, the legacy of Anna Craft and her collaborators continues to impact education (e.g. Gregoriou, 2023) and the broader field of Possibility Studies.

Overarching these conceptions of PT, Possibility Studies is rapidly becoming an emergent field of research spanning several disciplines (see Glăveanu, 2023b) and moving beyond the domain of education. Studying the possible covers a broad range of human activities, including storytelling, problem-solving, and future-making (Bruner, 1986). While PT reflects the sociocultural and situated ways in which people orient themselves toward the possible, it also reflects individual patterns in propensities to be aware of possibilities, to explore them, to be excited by them and, ultimately, to act on them. Thus, understanding the extent to which PT is both a case of an individual's traits or the surrounding environment, or indeed, an interaction between the two is an essential part of laying the foundations of this growing research domain.

Despite this growing interest in PT, to date there is no measure that researchers can use to study this orientation. Given the rapid development of PT research, having psychometrically sound assessments of this construct is critical. Various interventions aimed at cultivating PT or related phenomena, such as imagination, creative thinking, curiosity, and serendipitous encounters, among others, would benefit from having an additional evaluation of their impact. Without a standardized measure of PT then the effect of the applied research in Possibility Studies (such as that outlined in Glăveanu, 2023) is harder to quantify. Therefore, developing and validating a scale of PT is an essential step in helping to advance the field of Possibility Studies given the fact that scales offer the opportunity to conduct a rigorous assessment characterized by both conceptual validity and reliability of measurement.

Alongside measuring the impact of proposed interventions, researchers can benefit from including such a scale in their studies to better understand commonalities with and differences from related constructs. Take, for example, imagination and creativity; conceptually, the former tends to apply to the mental generation

of possibilities, while the latter tends to focus on actualizing concrete possibilities in new and meaningful outcomes. PT relies on both these forms of engagement—psychological and sociomaterial—and serves as an overarching concept for a range of processes that are identifiable and measurable on their own. More than this, when people understand their own orientation to the possible, they can foster their engagement with the possible by reflecting on their own practices and beliefs in this area. As in the foundational work by Craft and collaborators, this recent revival of the concept of PT has both important theoretical and practical implications.

However, there are also clear challenges when it comes to developing such a measure. One of these lies in measuring something as complex as PT. As mentioned, PT involves a series of actions, traits, and beliefs that are important for this phenomenon, too many to capture in a single factor. Fortunately, recent work has provided potentially helpful insights that can provide some guidance. For example, the action-basis of PT proposed by Glăveanu (2020a) and Beghetto (2023a) has aided us in conceptualizing three underlying factors that seem to constitute PT. Those three factors are: (a) being aware of the possibilities, (b) being excited about possibilities, and (c) exploring possibilities.

Awareness focuses on being open to discovering what is possible and creating opportunities for such emergence. It refers to the recognition, understanding or knowledge of new possibilities, including reevaluating what currently exists in a new way. Excitement (or arousal) refers to being motivated to continue discovering and exploring new possibilities. It captures the affective dimension of our engagement with the possible. Exploration refers to the pursuit, at once psychological and embodied, of specific possibilities and the purposeful examination of their processes and impacts. This includes a willingness for experimentation and trial-and-error with possibilities.

These three factors operate in close relation to each other since we often become aware of new possibilities when exploring existing ones, which in turn engenders excitement and fosters further explorations of the possible. And yet these three facets are distinct enough so that each one can be examined on its own, conceptually and methodologically (see Glăveanu, 2020b). We thereby assert that people's subjective assessment of their awareness, excitement, and exploration of the Possible can serve as an important first step in understanding their orientation toward PT and how it informs further action, including their willingness to enact specific possibilities. In other words, we view scores on this scale as capturing people's self-reflections when it comes to PT and its role and value.

In what follows, we report on four studies aimed at developing and validating a Possibility Thinking Scale (PTS). This scale has been developed to assess the three factors that we view as essential in people's orientation toward experiences of the possible: awareness, excitement, and exploration. The article ends with considerations related to limitations and new possibilities for research and practice.

The present studies

The main goal of the research program reported below is to develop and validate PTS: a concise yet valid and reliable instrument that allows for a measurement of the three aspects of PT: Awareness of the Possible, Excitement about the Possible, and Exploration of the Possible. We took a multistep approach to achieve this general goal. More specifically, we conducted four studies that examined the properties of the PTS. Studies 1 to 3 took a traditional psychometric approach: we collected data on the PTS and some relevant correlates (creativity, personality). We fit confirmatory factor analysis (CFA) models to compare two competitive, theoretically plausible models: one-factor (i.e. assuming one underlying latent factor of PT) and the theorized three-factor model. We replicated the findings across samples speaking Polish (Study 1) and English (Study 2), with a

third replication study (Study 3) conducted on an English-speaking sample.

Study 4, although oriented toward the same goal of refinement and selection of the final version of the PTS, took a slightly different approach. Collaboratively with Large Language Models (LLM), specifically GPT-4, new items were proposed, refined by the first author of this paper, and further discussed with the team of authors. Then, we repeated the CFA procedure to evaluate one- versus three-factor models of the expanded scale. Finally, we took a hybrid approach by merging confirmatory and exploratory perspectives in selecting the final items of PTS. To this end, we relied on network analyses and CFA to select final items that resulted in a satisfactory fit of the three-factor model that proved superior in previous analyses and excluded the most ambiguous items, that is, those characterized by robust cross-loadings across factors.

Given these steps, we present our results in two sections. The first uses data from Studies 1 to 3 and reports them together, while the second is based on Study 4 results. All data and analysis scripts are available in the Open Science Framework archive https://osf.io/n6u43

Possibility Thinking Scale: Initial explorations and replications (Studies 1–3)

Method

Participants

Study 1. Four hundred sixty-four participants (232 women) were selected from a larger group of $N = 594$. The remaining 130 participants did not pass our attention checks or provided string patterns of responses on self-report scales, a common sign of careless responding (Kung et al., 2018; McKibben & Silvia, 2017), so they were excluded. Participants' age ranged from 19 to 76 ($M = 40.09$; $SD = 12.95$) and they were Polish members of the Syno International Research Panel and participated online. In Study 1, all instruments were filled in Polish.

Study 2. Study 2 involved 314 participants (151 women), who were Prolific panelists and reported English as their first language. We excluded 14 participants who provided string patterns to 12 PTS items and one reversed trap item (see Measures section below). Participants' age ranged from 18 to 80 ($M = 39.73$, $SD = 13.96$).

Study 3. Study 3 involved 289 participants (146 women) who were Prolific panelists and reported English as their first language. Participants' age ranged from 18 to 77 ($M = 41.6$, $SD = 14.3$). This sample did not include participants of Study 2.

Measures

Possibility Thinking Scale (PTS, Studies 1–3). PTS used in Studies 1 to 3 consisted of 12 items (see Appendix A), with a 5-point response Likert scale (*1 = definitely not, 5 = definitely yes*) and one additional reversed trap item (Silvia et al., 2021) added to capture inattentive responding (participants with the same responses to all 13 items were marked as inattentive, there were 65 such participants overall in the case of the PTS in Study 1, 14 in Study 2, 0 in Study 3).

Creative agency (CA) (Studies 1–2). Participants' aspects of CA were measured by a modified Short Scale of Creative Self (SSCS 2.0) (Karwowski et al., 2018; Zielińska et al., 2022). SSCS 2.0 consists of eight items measuring creative confidence ("I can" perspective, $\omega = .91$, sample item: "I'm sure I can deal with problems requiring creative thinking") and eight measuring creativity centrality ("I am" perspective, $\omega = .88$; sample item: "Being a creative person is important to me"). Additionally, there was the ninth negatively phrased item per both scales ("I'm not particularly creative" for creative confidence and "Creativity is not important

to me") to detect inattentive respondents, as in the PTS.

Divergent thinking (Studies 1–2). In Studies 1 and 2, participants solved the Alternate Uses Task (AUT), providing original uses for a can. They were instructed to provide original and creative uses ("be creative instruction"). Time was not restricted in Study 1 and restricted to 3 min in Study 2. Following recent developments in the automated scoring of DT tasks (Organisciak et al., 2023), we scored the originality of the responses provided automatically using Open Creativity Scoring with Artificial Intelligence system (Ocsai, see https://openscoring.du.edu/scoringllm and Organisciak & Dumas, 2020). Polish responses were translated into English and then scored by Ocsai, following a recent procedure that resulted in scores highly aligned with human raters (Zielińska et al., 2023). Fluency was operationalized as the number of responses provided. Originality scores were obtained from a multidimensional top-scoring approach using the *R* package mtscr (Jędrusiak et al., 2023). More specifically, each participant's originality was estimated based on the two most original responses as assessed by Ocsai, however contrary to relying on two responses only as typically done in top-scoring (Silvia et al., 2008), multidimensional top-scoring procedure estimates participants' originality by using information on all generated items (see Forthmann et al., 2023, for more details).

Openness and extraversion (Study 2). To measure personality traits of Openness to Experience (O) and Extraversion (E) and their facets, we used 23 items from BFI-2 (Soto & John, 2017).[2] These items allowed us to measure the general trait O (11 items overall, $\omega = .84$) as well as its facets of creative imagination (four items, $\omega = .81$, sample item: "in inventive, finds clever ways to do things"), intellectual curiosity (three items, $\omega = .59$, sample item: "is complex, a deep thinker"), and aesthetic sensitivity (four items, $\omega = .75$, sample item: "values art and beauty"). Similarly, we measured the general trait E (12 items, overall, $\omega = .88$), as well as its facets: sociability (four items, $\omega = .87$, sample item: "is outgoing sociable"), energy (four items, $\omega = .71$, sample item: "shows a lot of enthusiasm"), and assertiveness (four items, $\omega = .79$, sample item: "has an assertive personality").

Procedure. In Study 1 and 2, participants started with a divergent thinking task or SSCS 2.0 (in random order) and then moved to PT. In Study 2, DT tasks were presented first, followed by questionnaires (BFI-2, SSCS, and PTS) in the randomized order. Study 3 presented the PTS at the end of a series of experimental measures that were outside of the interest of the current study[3] and lasted around 10 min.

Data analysis. Given our focus on presenting an initial validation of the PTS and replicating the findings across studies, in each study, we started with confirmatory factor analyses (CFAs) to compare theoretically considered models of PT. More specifically, we compared the most parsimonious one-factor model, with all 12 items loading on the common PTS latent factor, and confronted this model with a theoretically derived three-factor model, with correlated factors: Awareness of the Possible, Excitement about the Possible, and Exploration of the Possible. A comparison of the parameters of model fit between these models in each study (1–3) allowed us to conclude about the theoretical structure of the construct at hand. For transparency, we also note that we exploratorily tested two other models: a higher-order model, with three second-order factors loading the higher-order factor, and a more complex bi-factor model. However, given that a hierarchical model is mathematically equivalent to the three-factor models with correlated factors, and the bi-factor model did not converge (which is a well-identified problem with complex latent models; see Geiser et al., 2015) for simplicity,

Table 1. A summary of CFA models of the PTS structure across studies.

Model fit	Study 1 (Polish)		Study 2 (English)		Study 3 (English)	
	One factor	Three factors	One factor	Three factors	One factor	Three factors
CFI/TLI	.982/.978	.985/.981	.898/.876	.945/.929	.921/.904	.939/.921
RMSEA	.036 [.012, .054]	.033 [.00, .052]	.093 [.077, .110]	.070 [.052, .088]	.076 [.059, .094]	.069 [.050, .087]
SRMR	.034	.032	.058	.049	.051	.048
BIC	12,435	12,434	8,487	8,422	8,004	7,988

Note. CFI = comparative fit index; TLI = Tucker Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square; BIC = Bayesian information criterion (sample size adjusted).

we report a comparison between one- and three-factor models.

All models were estimated in lavaan for *R* (Rosseel, 2012), using a maximum likelihood estimator with robust standard errors (MLR) to account for the skewed distribution of the items. We relied on usually applied criteria (Cheung & Rensvold, 2002; Hu & Bentler, 1999) while evaluating models' fit: comparative fit index (CFI), Tucker-Lewis Index (TLI), root mean square error of approximation (RMSEA), standardized root mean residual (SRMR), and sample-size adjusted Bayesian information criterion (SSA BIC). CFI and TLI above .950 were considered indicative of a very good fit (with values about .90 indicating an acceptable fit), RMSEA and SRMR below .05 were treated as showing no significant misfit, and the lower SSA BIC was used to decide on the best-fitting model.

The next step involved correlational and regression analyses. We were particularly interested in the links between PT and aspects of creativity (divergent thinking, creative agency) and personality (O, E, and their facets).

Results

To explore whether respondents view PT as uni- or multidimensional construct, we first compared one versus three-factor models in each study to answer this question. Table 1 summarizes the parameters of model fit.

In Study 1, the one-factor model provided a good fit, with all items demonstrating robust factor loadings (all $\lambda s > .50$, ranging between .566 and .710, median $\lambda = .620$; see Figure 1 and the OSF Archive for more details). At the same time, however, the three-factor model, inspired by our theoretical predictions, was characterized by a slightly better fit. Notably, the difference in the Bayesian Information Criterion was negligible (ΔSSA BIC < 2), making a unanimous decision regarding the PTS structure in Study 1 premature.

A more apparent pattern regarding the PTS structure was observed when the results of Study 2 and Study 3 were analyzed. In the case of Study 2, the single-factor model was characterized by a visible misfit, while the three-factor model fit was acceptable. Also, in Study 3, there was a slight yet significant tendency for the superiority of the theorized three-factor model over the one-factor model (ΔSSA BIC = 16).

Thus, although our initial CFAs indicate that the theorized three-factor model is indeed the one that characterizes the PTS structure better than the single-factor solution, some concerns are still associated with the distinctiveness of the three factors. As illustrated in Figure 1, in all studies, we observed robust latent correlations between the factors of the PT, in seven out of nine cases above the threshold of $r = .85$, usually considered as a maximum association to conclude that variables are distinct (Clark & Watson, 1995; Kline, 2011).[4] Consequently,

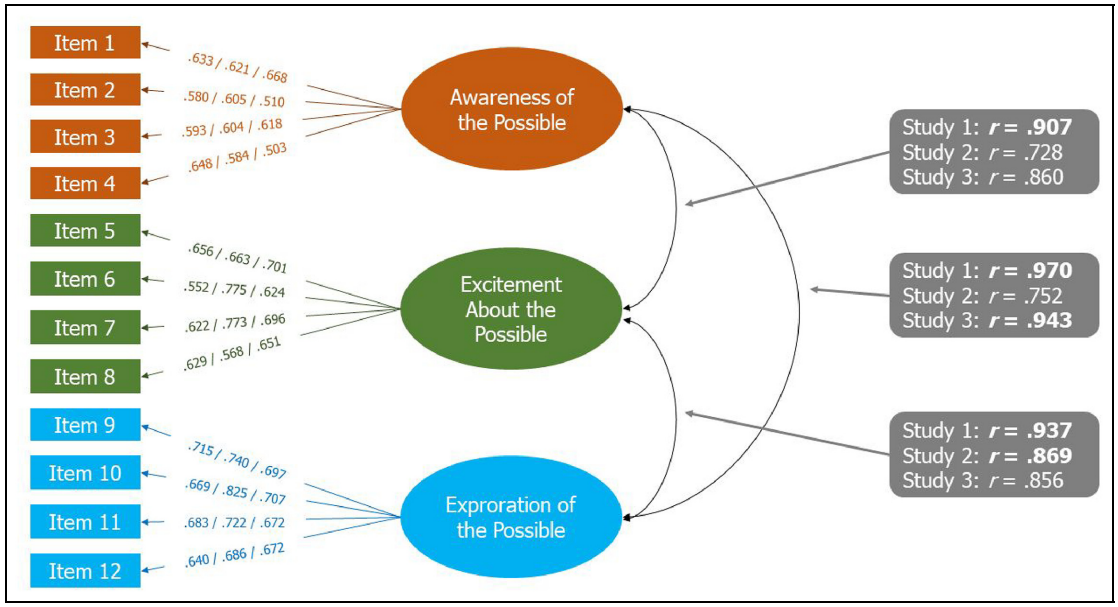

Figure 1. Confirmatory factor analysis models tested in Studies 1 to 3.
Note. Values on arrows are standardized factor loadings for Studies 1 to 3. See Appendix A for the wording of items.

although the three-factor models' fit was better than one factor, such strong associations are problematic regarding discriminant validity. We report our approach to obtain less strongly correlated factors in Study 4. First, however, we explore the links between PT, personality, and creativity.

How is possibility thinking related to creativity and personality?. Given the theoretical similarity of PT to creativity (and—more importantly—the role of PT for creativity), we explored the links between PT and participants' divergent thinking and their creative self-concept (Study 1–2). As illustrated in Table 2, across studies, we observed robust links between three factors of PT and aspects of creative agency, mainly creative confidence and centrality. Lower associations were observed when DT was taken into consideration: in Study 1, DT fluency tended to be weakly, yet significantly correlated with all scales of PTS, while no significant links with originality were observed; in Study 2, only the relationship between DT originality and the Awareness of the Possible yielded weak, yet significant correlation ($r = .12$, $p < .05$), while the remaining coefficients did not differ from 0.

Our second set of analyses involved traits and facets of two personality factors that are established correlates of creativity (Karwowski & Lebuda, 2016; Puryear et al., 2017) and, therefore, were considered vital to be checked against their link with PT: Openness and Extraversion. As presented in Table 3, PT was reliably linked mainly to Openness, with correlations with the overall trait between $r = .38$ in the case of Awareness of the Possible scale and $r = .52$ and $r = .54$ in the case of Exploration of the Possible and Excitement about the Possible respectively. At the facet level, relationships between creative imagination and intellectual curiosity and PT were higher than those between aesthetic sensitivity and factors of PT.

The links between PT factors and Extraversion were significant, yet weaker (*r*s between .19 in the case of excitement scale and

Table 2. Correlations between Possibility Thinking Scales and aspects of creativity: creative agency factors and divergent thinking (Studies 1–2).

Variables	Possibility thinking		
	Awareness	Excitement	Exploration
Creative agency			
Creative centrality	Study 1 $r = .54$ Study 2 $r = .36$	Study 1 $r = .53$ Study 2 $r = .50$	Study 1 $r = .54$ Study 2 $r = .49$
Creative confidence	Study 1 $r = .50$ Study 2 $r = .48$	Study 1 $r = .56$ Study 2 $r = .52$	Study 1 $r = .49$ Study 2 $r = .50$
Divergent thinking			
Fluency	Study 1 = .13 Study 2 = .04*ns*	Study 1 = .12 Study 2 = .10*ns*	Study 1 = .19 Study 2 = .10*ns*
Originality	Study 1 = .08*ns* Study 2 = .12	Study 1 = .06*ns* Study 2 = .03*ns*	Study 1 = .08*ns* Study 2 = −.04*ns*

Note. Study 1, $N = 464$, Study 2, $N = 314$. All correlations except those marked *ns* (nonsignificant) are significant at $p < .05$ level or lower.

Table 3. Correlations between Possibility Thinking Scales and traits O and E (and their facets).

Personality	Awareness	Excitement	Exploration
Openness	$r = .38$	$r = .54$	$r = .52$
Creative imagination	$r = .42$	$r = .53$	$r = .57$
Intellectual curiosity	$r = .35$	$r = .52$	$r = .46$
Aesthetic sensitivity	$r = .16$	$r = .30$	$r = .26$
Extraversion	$r = .25$	$r = .19$	$r = .32$
Sociability	$r = .10$*ns*	$r = .04$*ns*	$r = .16$
Energy	$r = .29$	$r = .26$	$r = .33$
Assertiveness	$r = .25$	$r = .20$	$r = .30$

Note. Study 2, $N = 314$. All correlations except those marked *ns* (nonsignificant) are significant at $p < .05$ level or lower.

$r = .32$ in exploration) and again varied depending on the facet of E. As presented in Table 3, they were weak and mostly nonsignificant in the case of facet sociability, while average in strength in the case of energy and assertiveness.

Given the covariance between personality facets and traits and their associations with creative agency factors (Lebuda et al., 2021), we estimated three hierarchical regression models to examine to what extent personality facets and creative agency aspects explain the variance in the scales of PT. We introduced the predictors in two blocks in each model, starting with personality facets and then adding creative confidence and centrality as predictors. Variance inflation factors were above 1 yet did not exceed 3.5 in either case; thus, we decided to proceed with the model without excluding any of the predictors.

As illustrated in Table 4, personality facets explained about 20% of the variability in the Awareness of the Possible and 34% to 35% in the Excitement about the Possible and Exploration of the Possible. Controlling for the links between predictors allowed us to disentangle the more specific links between each facet and possibility aspects. In the case of the Awareness of the Possible, apart from several significant links identified in a correlational

Table 4. A summary of hierarchical regression models with Possibility Thinking Scales results being predicted by personality facets (first block) and creative agency factors (second block).

Predictors	Awareness	Excitement	Exploration
Step 1 (personality)	$R = .47$, Adj. $R^2 = .20$	$R = .60$, Adj. $R^2 = .34$	$R = .60$, Adj. $R^2 = .35$
Sociability (E)	−.093*ns*	−.116 ($p = .058$)	−.031*ns*
Energy (E)	.149*	.069*ns*	.092*ns*
Assertiveness (E)	.096*ns*	.028*ns*	.061*ns*
Creative imagination (O)	.275***	.319***	.426***
Intellectual curiosity (O)	.165**	.313***	.186**
Aesthetic sensitivity (O)	−.084*ns*	.012*ns*	−.052*ns*
Step 2 (personality + CA)	$R = .50$, Adj. $R^2 = .24$, $\Delta R^2 = .036$	$R = .64$, Adj. $R^2 = .39$, $\Delta R^2 = .049$	$R = .62$, Adj. $R^2 = .36$, $\Delta R^2 = .021$
Sociability (E)	−.072*ns*	−.101*ns*	−.027*ns*
Energy (E)	.119 ($p = .057$)	.046*ns*	.084*ns*
Assertiveness (E)	.096*ns*	−.01*ns*	.051*ns*
Creative imagination (O)	.051*ns*	.083*ns*	.282***
Intellectual curiosity (O)	.159**	.301**	.175**
Aesthetic sensitivity (O)	−.069*ns*	.001*ns*	−.074*ns*
Creativity centrality	.033*ns*	.127*ns*	.151*
Creative confidence	.316***	.251***	.090*ns*

Note. Study 2: $N = 314$; All variance inflation factors < 3.5, $*p < .05$, $**p < .01$, $***p < .001$, *ns* = not significant.

analysis, only the Openness's facets of creative imagination (β = .275) and intellectual curiosity (β = .165) served as significant predictors, alongside Extraversion's facet of assertiveness (β = .149). When, in the second step, we added creative confidence and centrality to the model, these two agency factors were associated with almost 4% explained variability in the excitement more ($\Delta R^2 = .036$), with creative confidence being the only significant predictor (β = .316). Of note, adding creative agency factors to the model significantly diminished previously observed effects of creative imagination and energy, suggesting mediation, which is consistent with the previous literature (Lebuda et al., 2021).

In the case of Excitement about the Possible, personality facets explained 34% of this factor variability, with two facets of Openness: creative imagination (β = .319) and intellectual curiosity (β = .313) being the only two significant predictors of similar strength. Interestingly, when creative agency factors were introduced in the second step, they added 5% of the variance explained ($\Delta R^2 = .049$), again the only significant predictor being creative confidence (β = .251). This model shows an apparent full mediation between the Openness facet of creative imagination and the Excitement of the Possible as mediated by creative confidence, but not in the case of the relationship between the Openness facet of intellectual curiosity and Excitement of the Possible, which remained virtually the same after including creative confidence to the model.

When it comes to Exploration of the Possible factor, personality facets explained about one-third of its variability ($R^2 = .35$), and again, the only significant predictors were two facets of Openness: creative imagination (β = .426) and intellectual curiosity (β = .186). Although the pattern of predictors was the same as in the previous case (i.e. Excitement about the Possible), we emphasize that effect size varied between the previous and this model. Moreover, adding creative agency factors resulted in only slightly (yet significantly) improved prediction ($\Delta R^2 = .021$), yet, in this case, creative centrality served as a statistically significant predictor (β = .151). We also observed a significant decrease in the

association between creative imagination and Exploration of the Possible between two blocks in the model, suggesting that creative centrality mediated the previously observed relationship.

To summarize, although the structure of the predictors of three possibility factors was similar, it was not the same. Two facets of Openness: creative imagination and intellectual curiosity, served as relatively stable predictors of each PT aspect, while the others, like Extraversion's facet of energy, explained only the variability of Awareness of the Possible. The same observation applies to creative agency factors introduced to our models. Creative confidence tended to be significantly associated with Awareness of the Possible and Excitement of the Possible, while not with the Exploration of the Possible, while creative centrality explained a unique portion of the variability in the Exploration of the Possible, but not the remaining factors. Consistent with previous research, creative agency factors tended to share a significant portion of variability with Openness and Extraversion, yet mostly creative imagination facet, which might suggest a mediation effect in the case of creative imagination but less so in the case of intellectual curiosity, which tended to work as an independent predictor of all aspects of PT. Finally, the models presented were able to explain between 24% (Awareness of the Possible) and 39% (Excitement about the Possible) of the variance in the aspects of PT. Consequently, it is justified to conclude that although PT is associated with personality and creative agency or might be causally influenced by some stable factors (e.g. personality), it is not reducible to either Openness or Extraversion.

PTS emerging from the dialog with AI (Study 4)

Studies 1 to 3 provided promising arguments to consider PTS as a three-factor instrument. Moreover, the pattern of associations observed between the three scales and the remaining variables seemed reasonable based on previous theorizing and research. Still, there were some limitations to the results of Studies 1 to 3. Specifically, although we opted for a three-factor structure based on CFA, some initial analyses of the Polish version of PTS (Study 1) showed that a more parsimonious, one-factor scale might be sufficient. Moreover, a three-factor structure was characterized by very strong latent correlations between factors, with several latent *r*s of about .90, so above the threshold for considering variables as distinct.

Consequently, in Study 4, we aimed to develop the final three-factor structure of PTS, with a set of new items developed in a controlled and creative collaboration with large language models. Our initial goals did not change, that is, the scale was expected to be brief (preferably about 12–15 items total), having appropriate parameters of model fit in CFA, yet at the same time, with expected latent correlations between factors below or equal .85.

Method

Participants. Study 4 involved the members of the Prolific panel again, who did not participate in Studies 1 to 3. There were $N = 500$ participants, 50% women, age 18 to 79, $M = 41.53$, $SD = 13.99$. After exclusions (string patterns in PTS), the effective sample size used in the analyses was $N = 491$ (245 women).

Measure and procedure. The PTS used in Study 4 involved the items applied in Studies 1 to 3 (12 items + 1 control item) and nine new items developed by LLM, rephrased by the first author, and then discussed among team members. More specifically, we used a structured approach to work with OpenAI's GPT 4 model in the Playground application programming interface (API) to assist in generating the new items. First, we provided the LLM with our human definitions of each of the three constructs and our initial 12 items. Next, we prompted the LLM to propose three new items for each one of the three dimensions. The

following nine items were generated in collaboration with the LLM.

Awareness of the possible:

1. Even when situations seem dire, I am conscious that there are multiple pathways we could take to find a solution.
2. In brainstorming sessions, I often bring up ideas or suggestions that others hadn't considered before.
3. My capacity to visualize and comprehend different scenarios has helped me adapt more easily in changing circumstances.[5]

Excitement about the possible:

4. When faced with an obstacle, my first instinct is excitement at the new opportunities it brings rather than dismay.
5. I find joy in comprehending abstract concepts and possibilities as they give rise to innovative thoughts.
6. Dreaming about all potential outcomes from a decision fills me with anticipation and energy.

Exploration of the possible:

7. If one approach doesn't work out as planned, I'm motivated to test alternative strategies until one succeeds.
8. Experimentation isn't just something that's nice-to-have for me; it's absolutely essential in my process of navigating challenges or solving problems.
9. When confronted by uncertainties or gray areas, I derive satisfaction from investigating them further instead of avoiding them due to discomfort or fear.

We then tested the performance of the scale using these new items (as described in the sections that follow).

Data analysis. Our initial analytic approach resembled the one from Studies 1 to 3: we started with CFA, comparing the one versus (hypothesized) three-factor model. We conducted two CFAs: the first included only the "old" 12 items to examine the replicability of the previous findings, while the second CFA used all items: "old" and "new"—co-generated with AI.

Our second step of analyses involved a hybrid approach. After replicating previous findings and establishing the three-factor model as superior to the one-factor, we relied on Exploratory Graph Analysis (EGA; Golino & Epskamp, 2017) and network analyses to identify ambiguous items that might be cross-loaded by different PT aspects. We proceeded in several iterations, first excluding a small set of items (or a separate item) in each step and then examining the model fit of the obtained solution in CFA. Finally, we estimated some basic reliability indices and descriptive statistics for a set of selected items constituting the three scales of the PTS.

Results

Does the PTS structure replicate when only old items are considered?. The first step of the main analyses involved the same models as reported in previous studies. Thus, one-factor and three-factor models were compared, yet we used only the "old" 12 items. The results presented in Table 5 (see the upper part) speak to the superiority of the three-factor model. Although the one-factor model was characterized by an acceptable fit, the fit of the three-factor model was significantly better.

An analogous situation was observed when we repeated the analyses using all items. Again, the three-factor model's fit was significantly better than one factor.

Despite the superiority of the three-factor model, the previously observed strong latent correlations between PTS scales were also observed. When only the old items were used,

Table 5. A summary of CFA models of the PTS structure across studies.

Model fit parameters	One factor	Three factors
Old 12 items		
CFI	.955	.969
TLI	.944	.960
RMSEA (90% CI)	.063 [0.049, 0.076]	.053 [0.039, 0.068]
SRMR	.037	.033
BIC	13,834.723	13,806.881
All items (12 + 8 items co-generated with AI)		
CFI	.944	.960
TLI	.937	.954
RMSEA (90% CI)	.055 [0.047, 0.063]	.047 [0.039, 0.055]
SRMR	.040	.037
BIC	22,900.488	22,832.455

Note. CFI = comparative fit index; TLI = Tucker Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square; BIC = Bayesian information criterion (sample size adjusted).

the estimated correlations were as follows: Awareness-Excitement, $r = .908$; Awareness-Exploration, $r = .938$; Excitement-Exploration, $r = .887$. When we considered three factors obtained in the analysis with all items, the latent correlations were: Awareness-Excitement, $r = .910$; Awareness-Exploration, $r = .940$, and Excitement-Exploration, $r = .903$.

An iterative item selection based on the hybrid approach. Given that we observed entirely replicable empirical and theoretical arguments for a three-factor solution, in the final step, we attempted to select items that (a) will result in a better fitting three-factor solution, with (b) reliable scales, and (c) lower latent correlations between scales. We emphasize that this set of analyses is exploratory and limited to our dataset, so it might be specific (or biased) to our sample and requires replication. Below, we briefly describe the changes introduced in four iterations, while Figure 2 illustrates the relationship between items in each iteration, and Table 6 summarizes CFA results after changes.

Iteration 1. After checking for potentially ambiguous items with substantial cross-loadings, in iteration 1, we excluded one item from the Awareness scale (15: "In brainstorming sessions, I often bring up ideas or suggestions that others hadn't considered before") and one item from the Exploration scale (12: "When I hear other people tell me that what I'm trying to do is impossible, I still look for ways to make it possible"). Item 15 was co-constructed with AI and Item 12 was from our initial, human-constructed scale (see Figure 2, panel A, for the items and Table 6 for CFA results). As illustrated in Table 6, these exclusions resulted in a substantially better fit of the three-factor model, and latent correlations between factors decreased yet still were above the threshold of .85.

Iteration 2. Based on further visual inspection of the links between items (Figure 2, panel B), we selected another three items to be excluded, this time choosing one item from each scale: Awareness (4: "When I finally solve a problem, I know that there is more that I could still learn from revisiting the problem"), Excitement (7: "When I don't understand something, I enjoy thinking about it in different ways"), and Exploration (22: "When confronted with an ambiguous situation, I am encouraged to think even deeper about it and not give up"). Each of these items was from our initial, human-constructed scale.

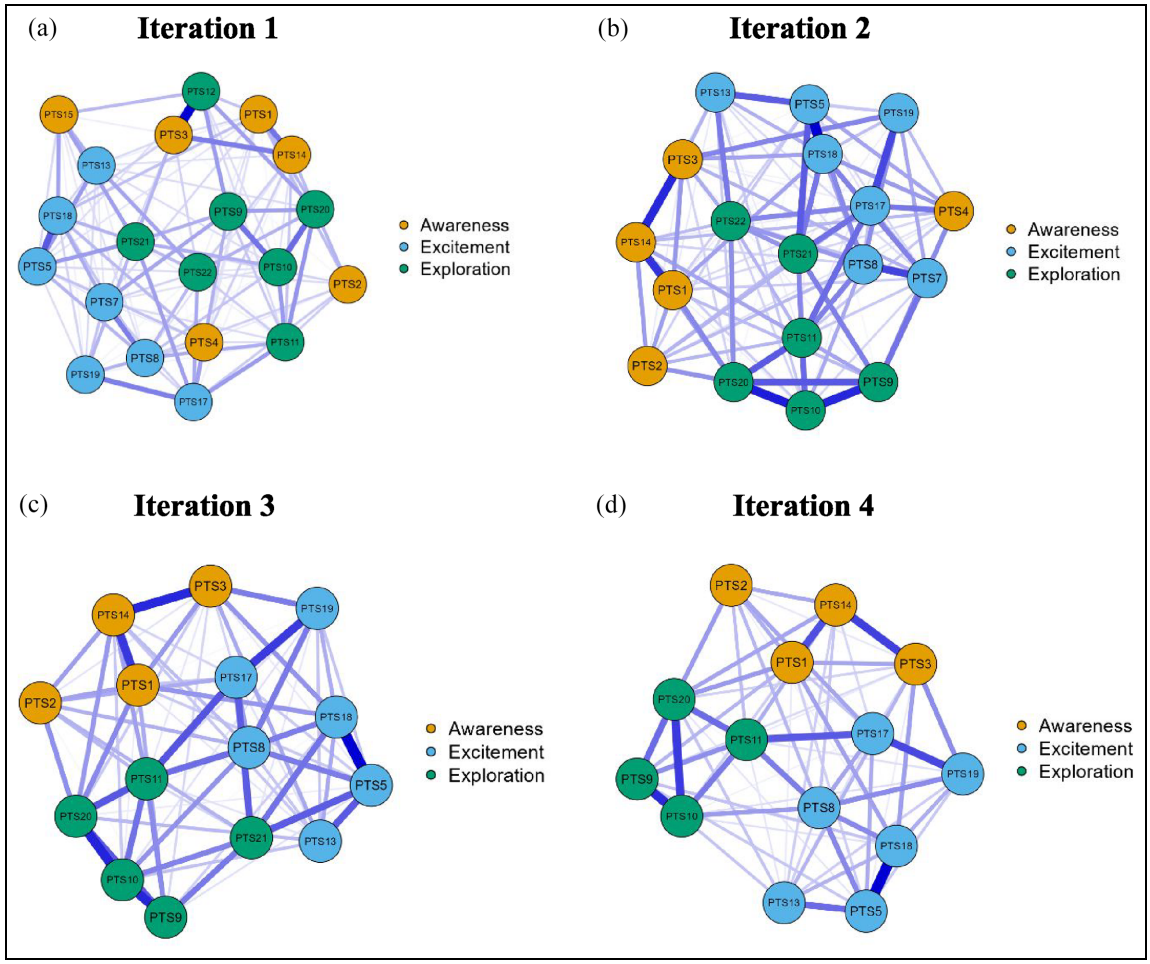

Figure 2. The links between PTS items in each iteration of ambiguous items' exclusion.
Note. For item wording, see Appendix B.

As illustrated in Table 6, the model fit parameters remained almost the same as in iteration 1 (with lower BIC indicating a better fit overall). Notably, all latent correlations between factors decreased below .90.

Iteration 3. The third iteration involved excluding one potentially ambiguous item from the Exploration scale (21: "Experimenting with ideas is something that comes natural to me when I try to solve a difficult problem") (Figure 2, panel C). This item was from our initial, human-constructed scale. CFA model fit improved, and latent correlations further decreased (Table 6, column "Iteration 3").

Iteration 4. Fourth and finally, in an attempt to select the most distinctive items and obtain the same number of items per scale, we decided to exclude two items from the Excitement scale: item 17 ("When faced with an obstacle, I am usually excited by the challenge ahead") and item 19 ("Daydreaming about all the potential outcomes from a decision fills me with excitement"). Both items were co-constructed with AI (see Figure 2, panel D).

Table 6. A summary of CFA models fit in each iteration.

Model fit	Three factors solution				
	Original model	Iteration 1	Iteration 2	Iteration 3	Iteration 4
CFI	.960	.976	.975	.986	**.991**
TLI	.954	.972	.969	.983	**.988**
RMSEA (90% CI)	.047 [0.039, 0.055]	.039 [0.029, 0.048]	.044 [0.032, 0.055]	.034 [0.018, 0.047]	**.030 [0.000, 0.047]**
SRMR	.037	.033	.034	.030	**.028**
BIC	22,832.455	20,502.234	17,303.191	16,111.022	**13,581.680**
Latent correlations					
Awareness-excitement	.919	.891	.867	.866	**.844**
Awareness-exploration	.940	.911	.883	.876	**.876**
Excitement-exploration	.903	.904	.874	.844	**.828**

Note. CFI = comparative fit index; TLI = Tucker Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square; BIC = Bayesian information criterion (sample size adjusted). Bolded Solution is the final, 12-item PTS scale.

Table 7. Descriptive statistics and reliability of the PTS scales.

	Items	Reliability	*M*	*SD*	Skewness	Kurtosis
Awareness	4	ω = .763 (95% CI [0.729, 0.798]) α = .762 (95% CI [0.725, 0.794])	3.686	0.704	−0.540	−0.960
Excitement	4	ω = .800 (95% CI [0.771, 0.829]) α = .795 (95% CI [0.763, 0.822])	3.545	0.786	−0.543	0.132
Exploration	4	ω = .830 (95% CI [0.805, 0.854]) α = .829 (95% CI [0.803, 0.853])	3.813	0.727	−0.851	0.973

As illustrated in Table 6, this final exclusion resulted in superior model fit (CFI = .991, TLI = .988, RMSEA = .030, 90% CI [0.000, 0.047], SRMR = .028. More importantly, however, two out of three latent correlations: between the Awareness and Excitement scales (r = .844) and between Excitement and Exploration Scales (r = .828) dropped below the criterion of $r \leqslant .85$. The correlation between Awareness and Exploration scales still exceeded this criterion (r = .876), yet we emphasize that we report latent, that is, "true" correlations. Observed correlations between scales (i.e. manifest, not corrected for unreliability and measurement error) were as follows: Awareness-Excitement, r = .659 (95% CI [0.606, 0.707]), $p < .001$, Awareness-Exploration, r = .698 (95% CI [0.650, 0.741]), $p < .001$, and Excitement-Exploration, r = .673 (95% CI [0.622, 0.719]), $p < .001$.

The resulting scale includes a total of 12 items, with four items used to measure each construct (see Appendix B). Nine of the 12 items were human-constructed items (i.e. three items to measure each of the three factors) and three human-AI co-constructed items (i.e. one item to measure each of the three constructs).

Descriptive statistics and reliability of the final PTS. Table 7 presents internal consistency reliability measures (McDonald's ω and Cronbach's

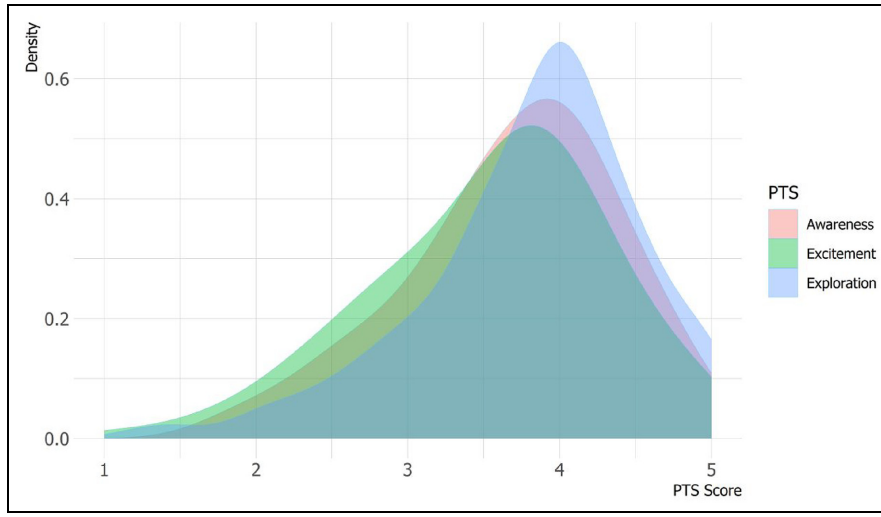

Figure 3. The distribution of PTS subscales.

α) and descriptive statistics, while Figure 3 illustrates scales' distributions. As shown, despite the conciseness (four items only), the scales are characterized by acceptable or good reliability (McDonald's $\omega \approx .80$ or higher in two out of three cases) and the distribution that does not deviate substantially from normality (skewness and kurtosis between -1 and 1; Mishra et al., 2019).

General discussion

The purpose of this article was to report on four studies that aimed to introduce and validate a scale for measuring people's orientation to the possible. As discussed, we focused on three interrelated factors that we view as central to people's disposition toward PT: Awareness of the Possible, Excitement about the Possible, and Exploration of the Possible. Our first goal was to examine whether the items of our scale represent three separate but interrelated factors.

Our results indicate that a three-factor model (awareness, excitement, and exploration of possibilities) best fits the data. In Studies 1 to 3, we found somewhat high correlations across the factors, with cross-loading of items among the three constructs. This would threaten discriminant validity. In Study 4, our aim was to improve performance of the scale by developing new items (co-constructed with AI) and removing problematic items through iterative testing of the models.

This resulted in a final scale of 12 items, comprised of nine items from the original scale and three new items co-constructed with AI. Our results from Study 4 indicate that the final scale performed better based on the data collected from our sample. Specifically, the 12 items aligned better with the three factors and demonstrated acceptable levels of discrimination of items across the three factors. The final scale with the factor labels and instructions provided to participants are included in Appendix B.

Our results from Study 4, thereby, provide initial evidence of a three-factor structure of the PTS. Subsequent research is needed to examine whether the three-factor structure holds across different populations of participants and contexts. That said, our findings are encouraging with respect to the way we have conceptualized

and measured people's orientation toward awareness, excitement, and exploration of the possible.

Our next goal was to explore whether the orientation to PT was associated with, but sufficiently distinct from related constructs. Specifically, we examined the relationship of the PT factors with creative agency (CA) and Alternate Uses Task (AUT) in Studies 1 and 2. We also explored facets of personality in Study 2. We briefly discuss the results in the sections that follow.

Possibility thinking: Creative agency and divergent thinking. Our results indicate that all three factors of our PT scale were positively associated with creative agency. This makes sense, given that one's orientation toward awareness, excitement, and exploration of possibilities represents an action-based disposition. It is well-established that the ability to exercise creative agency requires an awareness of actionable possibilities and the motivation (excitement) to take action and engage in exploring those possibilities (e.g. Karwowski & Beghetto, 2019).

With respect to indicators of divergent thinking (DT), our findings from Study 1 indicate positive albeit weaker correlations with PT. Specifically, we found a positive (albeit weak) association between fluency and the three PT factors. Again, this is somewhat to be expected as generating multiple possibilities is conceptually related to PT. That said, awareness, excitement, and exploration of possibilities differ from simply generating multiple ideas because they involve a motivational and action-based orientation that is attuned to noticing, enjoying, and actually engaging with what is possible.

With respect to generating original responses on the AUT, our findings were somewhat mixed. In Study 1, we found no relationship between PT and originality of responses on the AUT, whereas in Study 2, we found a weak association between Awareness of the Possible and originality of responses on the AUT. At first sight, these results may seem surprising as originality of responses might seem related to an orientation toward the three factors of PT. Upon further consideration, however, there may be weaker relationships as possibilities need not be original for people to be aware of them, excited about them, or willing to explore them. However, such an explanation—and alternative explanations—of this pattern of findings requires further studies.

Possibility thinking and facets of personality. In Study 2, we also explored whether conceptually related personality factors (i.e. facets of Openness to experience and Extroversion) were related to the three factors measured by PTS. Our correlational results indicate that all three facets of Openness (i.e. creative imagination, intellectual curiosity, and aesthetic sensitivity) were positively associated with the three factors assessed by PTS. Again, this makes conceptual sense, given that creative imagination has long been viewed as a core feature of PT (Craft, 2015).

It also makes sense that people who tend to be intellectually curious and have aesthetic sensibility would be more oriented toward being aware of the possible, excited by the possible, and willing to explore it. This is because wonder and curiosity serve as core features of the possible (Glăveanu, 2020b). And aesthetic sensitivity also reflects a disposition toward being aware of, enjoying, and being willing to explore the beautiful and good afforded by new possibilities. That said, not all possibilities have a positive valence; some can be viewed as bad, dangerous, unappealing, and even harmful. This may be why the relationships, albeit positive, are variable (ranging from low *r*'s .16 and .26 to moderate and strong *r*s of .35 to .52).

A similar, albeit weaker, pattern of associations was found in the relationships among facets of Extraversion (sociability, energy, and assertiveness) and the three factors of PT. In fact, sociability was not related to Awareness or Excitement of the Possible and only weakly related to Exploration of the Possible ($r = .16$). Conversely, energy and assertiveness were modestly associated with the three factors. One

explanation for this pattern is that the factors of PT involve some level of energy and assertiveness. However, PT also involves more internal reflection and thought. Indeed, although PT is conceptualized as a relational phenomenon, which requires some level of energy and assertiveness, it is not limited to or strongly associated with people who tend to be more extraverted.

Finally, our multivariate model in Study 2 demonstrated that with respect to Awareness of the Possible, only creative imagination, intellectual curiosity, and assertiveness served as unique predictors. When we added creative confidence to the model, it also accounted for unique variance, reducing the effects of creative imagination and intellectual curiosity.

In alignment with previous research on creative confidence (Lebuda et al., 2021), these results suggest that creative confidence might mediate the relationship between relatively stable personality traits and more dynamic and action-related possibility thinking. Indeed, we observed that people who are more creatively imaginative and intellectually curious may tend to have higher creative confidence that, in turn, increases their awareness of the possible. Further research is needed to test and verify these findings and whether this mediated relationship holds across other populations and studies.

With respect to excitement of the possible, our findings from Study 2 also indicate that creative imagination and intellectual curiosity serve as unique predictors of Excitement of the Possible, with creative confidence also serving as a unique predictor and a mediator between creative imagination and Excitement of the Possible. This pattern of findings indicates that while creative imagination works through creative confidence, intellectual curiosity has a more direct relationship with this particular factor. This is a potentially interesting nuance of mediation that warrants further research.

When it comes to exploration of the possible, our findings from Study 2 indicate that creative imagination and intellectual curiosity again serve as unique predictors, but the creativity centrality (i.e. the importance of creativity to one's identity) and not creative confidence factor served as a unique and mediating predictor. These results provide further nuance in our findings with respect to creative agency beliefs.

Whereas creative confidence seems to play a unique and mediating role in the relationship between creative imagination and intellectual curiosity for Awareness and Excitement about the Possible, creative centrality is more important both in predicting and mediating the relationships between personality and Exploration of the Possible. These findings suggest that people who see themselves as more creatively imaginative and intellectually curious also tend to view creativity as more central to their identity and, in turn, indicate that they are more willing to explore possibilities. Again, given the correlational nature of this study, this pattern of relationships warrants further testing prior to making strong conclusions about this relationship.

Taken together, our findings from Studies 1 to 4, provide initial validation of the three-factor model of the PTS and offer initial convergent and discriminant validity. Our findings from Studies 1 and 2, also highlight interesting and somewhat nuanced patterns of relationships, suggesting that people's orientation toward possibilities is associated with conceptually related creativity and personality factors, but that relationship is somewhat nuanced and distinct from those factors. These findings can serve as a basis for possibility studies researchers interested in using the PTS in their own work.

Limitations and future directions

There are limitations associated with the initial validation of this scale, most of them pointing to new possibilities for research. First, the final version of the scale requires further empirical validation, ideally in a broader range of cultural contexts, in relation to various spheres of activity (to explore domain specificity), and across

different ages (within longitudinal studies). An independent confirmatory factor analysis on a different sample is the next step in this process, one that re-confirms the three-factor solution over a unidimensional interpretation. Since our engagement with the possible is highly contextual, it will be also important to study how PTS can be used to capture the impact of different situational constraints, environmental conditions, and experimental interventions. With the help of the latter, we could explore if fostering one of the three dimensions in particular—awareness, exploration, and excitement—has an impact that generalizes to the other dimensions as well and, by extension, discover when and how to foster the different facets of PT. New correlates should also be added to future studies, for example motivational orientation, work preference, "locus of causation" and autonomy, thus using new conceptual lenses—for example, Self-Determination Theory (Ryan & Deci, 2000)—to uncover the dynamic of the possibility in everyday life. Different forms of this scale should be developed in the future to facilitate its use in pre-test post-test designs. Since this scale is based on self-report, it would also be useful to test its relation to real-world activities and achievements further and assess its predictive validity. Last but not least, more conceptual work is required to explore PT as an orientation, set of values and identity position rather than a fixed trait or ability. This is in line with the original theorization of PT and the pragmatist, sociocultural ethos underlying its re-emergence within possibility studies.

Conclusions

PT is a key concept allowing us to grasp our complex relationship with the "not yet here," the "elsewhere," and the "nowhere." This article reports on the construction and preliminary validation of a scale for PT, a unique development with important theoretical, methodological, and practical implications. On a theoretical level, there is further confirmation of the fact that PT is not a unitary phenomenon but a dynamic and multi-faceted one. Within it, becoming aware of new possibilities, being excited about their emergence, and continuing to explore their implications, are three distinct yet interrelated factors. This finding confirms, once more, the importance of situating PT within the intersection of the psychological, social, material, cultural, and political. Awareness, excitement and exploration are not mere psychological phenomena but depend on the person's interdependence with a wider human, non-human and more-than-human world of objects, people, places, spaces, and chance events. Methodologically, this wide ecosystem presents a fundamental challenge for researchers who need to examine and oftentimes measure PT as an orientation toward the possible. Creating and validating a scale is a psychometric process that comes with its own benefits and limitations. What is important is how a scale like the PTS is understood and used. This is not an instrument meant to offer a simple, numerical value for an assumed internal and stable ability or trait. PTS is based on self-report around attitudes about, preferences for and experiences of possibility. As such, it is best equipped to capture dispositions rooted in action and inter-action. This is why, practically, the PTS can serve a variety of purposes when it comes to evaluating, accompanying, and fostering an individual's or group' transformative engagement with the possible (see also the notion of Possibility Spaces in Glăveanu, 2023c). Ultimately, the value of PTS rests in the positive outcomes that can be reached through its use. And this use depends on how rigorous, conceptually coherent, and empirically solid the tool proves to be. The present paper hopes to have contributed to achieving this worthy aim.

Declaration of conflicting interests

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Notes

1. https://www.ronaldbeghetto.com/ptbots
2. Due to a technical glitch one item of the O scale, denoting intellectual curiosity, was not properly asked, thus the total number of items was 23, not 24.
3. Reported in Beghetto et al. (Manuscript Under Review).
4. Note that this criterion is often used against a correlation between manifest, that is, observed, variables rather than factors modeled in latent variables framework as reported in this paper. Thus, our approach might be considered conservative. Moreover, the threshold or $r = .85$ is not the only one present in the literature, some authors do suggest that the correlations exceeding $r = .90$ should be considered as indicative of poor discriminant validity (Gold et al., 2001; Teo et al., 2008).
5. Due to a technical glitch, this item was only asked to half of all participants, therefore it was omitted in analyses, resulting in eight new items co-created with AI.

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Appendix A

Version 1: Possibility Thinking Scale (Studies 1–3)

Please rate your level of agreement with the following statements. Please note: There are no correct answers, just honest answers.

Awareness of the possible subscale

- When I get really stuck trying to solve a problem, I know that it is possible to find a solution.
- When I make mistakes, I am aware that mistakes represent new possibilities for moving forward.
- When I hear someone say something that seems impossible, part of me knows that it may still be possible.
- When I finally solve a problem, I know that there is more that I could still learn from revisiting the problem.

Excitement about the possible subscale

- When I don't have a problem to solve, I still enjoy to play with ideas and discover new ways of looking at things.
- When I think about my professional work, I like coming up with different possibilities for how I can do my work differently.
- When I don't understand something, I enjoy thinking about it in different ways.
- When I don't know what to do or think, I still enjoy thinking about different ways that I can move forward.

Exploration of the possible subscale

- When I don't know how to solve a problem, I try to discover as many possible solutions as I can.
- When I face a very difficult challenge, I try to explore the challenge in many different ways.
- When I try something new and fail, I keep looking for new possibilities for how to be successful.
- When I hear other people tell me that what I'm trying to do is impossible, I still look for ways to make it possible.

The trap item

- Often when someone says something is possible, deep down I know it's really impossible.

Appendix B

Version 2: The final scale and items excluded (Study 4)

The numbers in brackets denote the items' numbers used in Study 4. Strikethrough of text denotes items that were excluded based on our iterative testing of the scale.

Awareness of the possible subscale

- When I get really stuck trying to solve a problem, I *know* that it is possible to find a solution. [PTS1]
- When I make mistakes, I am *aware* that mistakes represent new possibilities for moving forward. [PTS2]
- When I hear someone say something that seems impossible, part of me *knows* that it may still be possible. [PTS3]
- ~~When I finally solve a problem, I *know* that there is more that I could still learn from revisiting the problem. [PTS4] [Excluded in Iteration 2, see Study 4 Results]~~
- Even when situations seem dire, I am conscious that there are multiple pathways we could take to find a solution. [PTS14]
- ~~In brainstorming sessions, I often bring up ideas or suggestions that others hadn't considered before. [PTS15] [Excluded in Iteration 1, see Study 4 Results]~~

Excitement about the possible subscale

- When I don't have a problem to solve, I still *enjoy* to play with ideas and discover new ways of looking at things. [PTS5]
- When I think about my professional work, I *like* coming up with different possibilities for how I can do my work differently. [PTS13]
- ~~When I don't understand something, I *enjoy* thinking about it in different ways. [PTS7] [Excluded in Iteration 2, see Study 4 Results]~~
- When I don't know what to do or think, I still *enjoy* thinking about different ways that I can move forward. [PTS8]
- ~~When faced with an obstacle, my first instinct is excitement at the new opportunities it brings rather than dismay. [PTS17] [Excluded in Iteration 4, see Study 4 Results]~~
- I find joy in comprehending abstract concepts and possibilities as they give rise to innovative thoughts. [PTS18]
- ~~Dreaming about all potential outcomes from a decision fills me with anticipation and energy. [PTS19] [Excluded in Iteration 4, see Study 4 Results]~~

Exploration of the possible subscale

- When I don't know how to solve a problem, I *try to discover* as many possible solutions as I can. [PTS9]
- When I face a very difficult challenge, I *try to explore* the challenge in many different ways.[PTS10]
- When I try something new and fail, I *keep looking* for new possibilities for how to be successful. [PTS11]
- ~~When I hear other people tell me that what I'm *trying to do* is impossible, I still look for ways to make it possible. [PTS12] [Excluded in Iteration 1, see Study 4 Results]~~
- If one approach doesn't work out as planned, I'm motivated to test alternative strategies until one succeeds. [PTS20]
- ~~Experimentation isn't just something that's nice to have for me; it's absolutely essential in my process of navigating~~

~~challenges or solving problems [PTS21] [Excluded in Iteration 3, see Study 4 Results]~~

- ~~When confronted by uncertainties or gray areas, I derive satisfaction from investigating them further instead of avoiding them due to discomfort or fear [PTS22] [Excluded in Iteration 2, see Study 4 Results]~~

The trap item

- Often when someone says something is possible, deep down I know it's really impossible.

Appendix C

Trap item, inattentive responding and scoring

We recommend using 13 items: 12 + trap (negatively worded item). Notably, the control item is not to be recoded/the scale to be reversed, but instead, it is used to catch careless participants: those who provide the same responses to all PTS items. Thus, depending on the statistical package one uses, the procedure should be as follows (below is SPSS version).

Step 1. Identify and exclude careless respondents

```
compute careless = 0.
exe.
count resp1 = PTS1 to PTS13 (1).
count resp2 = PTS1 to PTS13 (2).
count resp3 = PTS1 to PTS13 (3).
count resp4 = PTS1 to PTS13 (4).
count resp5 = PTS1 to PTS13 (5).
exe.
if resp1 = 13 or resp2 = 13 or resp3 = 13 or resp4 = 13 or resp5 = 13 careless = 1.
exe.
## filter out if careless = 1.
```

Step 2. Compute PTS scales (items should be presented in a random order)

```
compute awareness = mean(PTS1 to PTS4).
compute excitement = mean(PTS5 to PTS8).
compute exploration = mean(PTS9 to PTS12).
exe.
```