An Improved Taxonomy of Creativity Measures Based on Salient Task Attributes

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This research was supported was not supported by any grants. We thank the research assistants who helped coding the measures. For all measures, we have reported example items, besides we report data exclusion criteria. The sample items along with the human ratings are available in the OSF <https://osf.io/e49n3/>.

Abstract

The assessment of creativity presents major challenges. The many competing and complementary ideas on measuring creativity have resulted in a wide diversity of measures, making it difficult for potential users to decide on their appropriateness. Prior research has proposed creativity assessment taxonomies, but we argue that these have shortcomings because they often were not designed to (a) assess the essential assessment features and (b) are insufficiently specified for reliably categorizing extant measures. Based on prior categorization approaches, we propose a new framework for categorizing creativity measures including the following attributes: (a) measurement approach (self-report, other-report, ability tests), (b) construct (e.g., creative interests and attitudes, creative achievements, divergent thinking), (c) data type generated (e.g., questionnaire data vs. accomplishments counts), (d) prototypical scoring method (e.g., consensual assessment technique; CAT), and (e) psychometric problems. We identified 228 creativity measures appearing in the literature since 1900 and classified each measure according to their task attributes by two independent raters (rater agreement Cohen's kappa .83 to 1.00 for construct). We provide a summary of convergent validity evidence and psychometric shortcomings. We conclude with recommendations for using the taxonomy and some psychometric desiderata for future research.

Keywords: Creativity; Divergent Thinking; Self-report; Other-report; Taxonomy

Despite a long history of creativity research and the great interest in understanding and measuring creativity, the question of how best to assess creativity in a psychometrically sound manner remains unsolved (e.g., Barbot et al., 2019; Long et al., 2014; Plucker & Makel, 2010). This can be attributed to the challenges of defining creativity (e.g., Barron, 1955; Runco & Jaeger, 2012) and because of its vagueness, the boundaries between creativity and other constructs, such as problem-solving (Weisberg, 1988), openness to experience (Feist, 1998; McCrae, 1987), and general retrieval ability (Forthmann, et al., 2019) appear indistinct. Nevertheless, the assessment of creativity is crucial, when it comes to forwarding our understanding of creativity (e.g., such as in the large-scale comparative assessments of creative thinking in children [PISA 2021; OECD: PISA 2021; Vincent-Lancrin, 2017]).

Before we provide measurement attributes for an improved and exhaustive categorization system, we describe previous categorization attempts in the next paragraphs.

Previous Categorization of Creativity Assessment

The creativity literature provides several taxonomies for categorizing research and measurement (e.g., Snyder et al., 2019). Extant taxonomies vary widely concerning terminology, as they are often based on different theoretical approaches and serve different purposes. Table 1 summarizes prominent taxonomies and categorization systems presenting the original labels and our attempt to unify terminology (primarily included attributes), which will be further described in the section “Building upon previous taxonomies”.

Table 1***Previous Taxonomies with Topic Coverage***

Authors	Original categorization/taxometric approach	Primarily included attributes
Rhodes, 1961	process, product, person, press
Hocevar, 1981	ten measurement categories (e.g., divergent thinking, product judgments)	α
Mumford & Gustafson, 1988	nomological net of creative potential (e.g., environment, skills/abilities, and personality)
Lubart, 1994	eight measurement categories (e.g., peer reviews)
Eysenck, 1996	trait (e.g., personality and ability) or achievement measures
Amabile, 1996	assessment techniques (e.g., tests, subjective judgment)	$\triangle$
Kirschenbaum, 1998	nine dimensions of creative activity (e.g., interest)
Mayer, 1999	psychometric, psychological, biographical, biological, computational, contextual
Plucker & Makel, 2010	process, person, environment	$\triangle$ α
Batey, 2012	facets (e.g., process, product), measurement approach (e.g., self-rating), and level (e.g., individuals)
Long, 2014; Long & Plucker, 2015	case studies, experimental paradigms, and questionnaire approaches	$\triangle$
Forgeard & Kaufman, 2016	constructs (e.g., imagination, creativity, and innovation)	α
Barbot, et al., 2019	Divergent thinking, product assessment, self-reports	$\triangle$ α
Benedek et al., 2019	task-type (e.g., problem-solving) and neuroscience method	$\triangle$ α
Kaufman, 2019	focus (e.g., activities, evaluation, process)	α
Snyder et al., 2019	measurement types (e.g., self-, and other measures) and category (e.g., process, person)	$\triangle$
Said-Metwaly, et al., 2019	process, product, person, press	α

Note. = measurement approach; = construct; = data type; $\triangle$ = scoring; α = psychometric problems.

One categorization approach—which has been further applied and developed in later taxonomies—describes the process of creativity, the creative product, the creative person, and

the environment in which creativity arises (4 P's; Rhodes, 1961). This approach to understanding creativity has been further applied and developed as a categorization basis (e.g., Batey, 2012; Plucker & Makel, 2010; Snyder et al., 2019; Said-Metwaly et al., 2019). A systematic review by Snyder and colleagues (2019) included measures from 1984 to 2013 that were coded by the type of measurement (e.g., self-rating of creativity) and related to the 4 P's. A categorization approach by Batey (2012), includes the 4 P's as facets, next to a categorization by the measurement approach (e.g., self-rating) and the observational unit (e.g., team).

Other taxometric approaches categorized measurements either very broadly by the research purpose (e.g., case-studies: Long, 2014; Long & Plucker, 2015; biological: Mayer, 1999; neuroscience (interdisciplinarity): Benedek et al., 2019) or describe measurement categories. The description of measurement categories vary in their breadth and overlap. Hocevar (1981) distinguished ten measurement categories (such as divergent thinking, product judgment), while Lubart (1994) used eight such categories (including peer-reports, divergent thinking) and Barbot (2019) classify indicators as divergent thinking, product assessment, and self-reports. Divergent thinking tasks are particularly prominent in the literature and appear in many taxonomies—either described as measurement approach, construct or even data type (e.g., Batey, 2012; Barbot, et al., 2019; Plucker & Makel, 2010). Besides the measurement type, other research focusses on the measurement content describing, for example, different dimensions of creative activities (e.g., Kirschenbaum, 1998), different constructs (imagination, creativity, and innovation; Forgeard & Kaufman, 2016), or different foci (e.g., activities; Kaufman, 2019). Other prominent approaches focus on the assessment technique (e.g., product assessment; Amabile, 1996), data distributions (Eysenck, 1996), and nomological net (Mumford & Gustafson, 1988).

Building upon Prior Categorizations

Previous categorizations are difficult to reconcile because they are based on different terminology and were originally intended to address creativity assessment from specific angles and foci. However, these approaches are of great value, when it comes to the development of an overarching categorization approach. Besides, they can help to identify previously used terminologies in the fields and to harmonize prospective usage. For example, the content measured in creativity tests has been described as constructs (Forgeard & Kaufman, 2016), focus (Kaufman, 2019), creative-activity (Kirschenbaum, 1998), or facet (Batey, 2012). Building upon prior categorizations we have identified the following task attributes: 1) measurement approaches (allows a broad and general categorization), 2) construct (a theoretical description of the content), 3) data type, 4) scoring recommendations, and 5) psychometric problems. Table 1 includes the previous taxonomies' original terminology and shows which of the aforementioned attributes are already represented in the taxonomy. As an example: The measurement types (Snyder, et al., 2019), task types (Benedek et al., 2019), measurement approaches (e.g., Batey, 2012), and measurement categories (e.g., Hocevar, 1981) all refer to the same attribute: the measurement approach (e.g., self-report). The attribute "construct" describes the underlying traits (e.g., imagination, Forgeard & Kaufman, 2016; beliefs, Kaufman, 2019) or abilities measured (e.g., divergent thinking).

Based on these frameworks, we propose a taxonomy, including theoretically derived task attributes that combine, complement, and enrich previous categorization approaches (see Table 2).

Table 2*A Taxonomy of Measuring Creativity, including Task Attributes.*

Task Attributes	Self-report			Other-report				Ability Tests	
	Preferences		Accomplishments	Preferences		Accomplishments		Performance	
Construct	Creative interests and attitudes	Creative Personality (e.g., Ingenuity)	Creative achievements/activities (e.g., on the job)	Creative attitudes & characteristics	Divergent thinking	Archival ratings (e.g., eminent people)	Original outcomes (e.g., patent indices)	Divergent thinking (fluency, flexibility, originality)	Insight problems
Data type	Questionnaire-data (Cattell, 1958): Subjective data		Life-data (Cattell, 1958): Biographical data	Questionnaire-data (Cattell, 1958): Subjective data		Life-data (Cattell, 1958): Objective data		Test-data (Cattell, 1958): Objective data	
Prototypical Scoring	Average scale scores		Sum of self-nominations (rating-scale of accomplishments)	Averaging scale scores/Agreement of raters		Agreement of raters/experts: Consensual Assessment Technique (CAT)		Divergent thinking: Fluency, flexibility, originality assessed by agreement of raters	Insight: proportion attainment of objectively correct responses
Psychometric Problems	Introspection of the individual; Highly fakeable; Shortcomings of self-report; Evaluation of originality, novelty, and fluency; Convergent Validity		Introspection of the individual; Fakeable; Shortcomings of self-report; Unusual data distribution; Convergent validity	Convergent validity; Inter-rater reliability: familiarity with creativity and familiarity with the target; Artifact of the assessment object		Inter-rater reliability; Bipartite definition of creativity: usefulness and novelty; Domain-specific		Divergent Thinking: Inter-rater reliability; intelligence and speed as sources of variance	Insight: Assessment of novelty and originality

It presents three major measurement approaches: self-report measures, other-report measures, and ability tests. These measurement approaches, at the apex of the hierarchy, offer a broad disjunct categorization. The measurement approaches are divided by preferences and accomplishments (self-, and other-reports) and performance. These subcategories are derived from different task requirements (preferences: report your/others typical behavior; accomplishments: frequency/rating of (previous) attainments; performance: produce creative ideas/solve a creative problem). Each of these measurement approaches require specification of further task attributes—constructs, data types, prototypical scoring, and specific psychometric problems—allowing a more precise categorization of a measure. Categorization of an assessment by measurement approach and construct allows an easy and straightforward categorization. The other task attributes offer a descriptive tool nested below the measurement approaches. The different data types usually come with a specific behavior of the participant and response style (Questionnaire data: Typical behavior reported on a Likert Scale; Life-data: Maximal effort/skill-related typical behavior on a checklist; and Test-data: Maximal cognitive effort in open-ended answers). This leads to prototypical scoring recommendations (e.g., the consensual assessment technique; CAT, Amabile, 1982) and specific limitations.

Creativity Measures Published Since the 1900s

Previously published measures were identified based on a focused literature review, following a predefined protocol. We searched online using Google Scholar, Web of Science, Research Gate, PsycINFO, and in the Educational Testing Service (ETS) Test collection. We identified tests based on the following phrases, in different search engines: *measures, assessment, questionnaire, test, creative, creativity, divergent thinking, flexibility, fluency, originality, ingenuity, gifted child, talent, eminent people, biographical, creative achievements, creative behavior, -interests, -attitudes, - styles, -personality*. Additionally, we searched through previous reviews, special issues, and book chapters on creativity and its

measurement, applying forward and backward search through the cited and citing literature. This for example included the APA's Division 10 database "Creativity and Arts Tasks and Scales: Free for Public Use" (<https://osf.io/4s9p6/>). This expands inclusion to measures not represented by the keywords. We included measures ranging from single-item to numerous items and scales. We excluded tests and articles that were limited in at least one of the following ways: (a) published only in languages other than English, (b) constructs only partially related to creativity—such as innovation (a key term that is primarily prevalent in business journals that describe practical realization of original ideas; Forgeard & Kaufman, 2016)—or problem-solving; (c) were not published or at least applied in a (larger) empirical study that would allow an assessment of psychometric properties; and (d) did not provide item examples, which are obviously indispensable for further evaluation in this review. Indices that are applied to rate the creativity of a state or country (also including infrastructure or cultural environment) were also excluded (e.g., creative economy; Correia, 2014). We acknowledge that due to the exclusion criteria, tests that some researchers might regard as creativity tests are not included.

Figure 1 shows an overview of the $N = 228$ measures identified in this review and their categorization by measurement approach and construct. Please note that a comprehensive list of all measures, including sample items and the original source of the measures, is available in the OSF (<https://osf.io/e49n3/>). Ability tests are most prominent in the literature ($n = 132$), followed by self-report measures ($n = 59$) and other report measures ($n = 37$).

Figure 1.

Note. Creativity indicators: [blank] = Divergent Thinking, blank = insight; [X pattern] = Attitudes & characteristics, [horizontal lines] = Divergent Thinking, [vertical lines] = Archival, [horizontal lines] = Outcomes, [diagonal lines] = Interest and attitudes, [diagonal lines] = Personality, [vertical lines] = Achievements, and [wavy line] = Activities.

Applying the Proposed Taxonomy

In the following paragraph, we first describe the results of two independent raters that categorized all tests presented in Figure 1 with respect to our proposed taxonomy. Next, we further apply the taxonomy, by providing a detailed description of all attributes and embed all the identified measures in the taxonomy.

The raters were provided with a general description of all constructs and a table including the test name, the author, and a minimum of one sample item (e.g., Write a paragraph about the theme “a tree”; Ekstrom, et al., 1976). Based on this table, the raters rated

(0 = construct does not apply; 1 = construct does apply). These results are provided in the OSF (<https://osf.io/e49n3/>). After the rating, the agreement between the raters was analyzed based on Cohen's kappa (Cohen, 1960). Table 3 displays the kappa for categorizing the construct, along with the percentage of agreement. In a further meeting of raters' consensus for all categories was reached.

Table 3

Cohen's Kappa (κ) and Percentage of Agreement for Two Independent Raters for the Measurement Construct and Construct.

Construct	Cohen's Kappa (κ)	Percentage of Agreement
Self-report (Construct: Interest & Attitudes)	.84	97.4%
Self-report (Construct: Personality)	.83	97.4%
Self-report (Construct: Achievements)	.92	99.1%
Self-report (Construct: Activities)	.83	99.1%
Other-report (Construct: Divergent Thinking)	1.00	100%
Other-report (Construct: Attitudes & Interests)	1.00	100%
Other-report (Construct: Archival)	1.00	100%
Other-report (Construct: Outcome)	1.00	100%
Ability Test (Construct: Divergent Thinking)	.99	99.6%
Ability Test (Construct: Insight)	1.00	100%

Self-Report

In the following, we describe the measurement approach *self-report*, by defining its constructs, data-types, and scorings. Next, we present measures that have been identified as self-report measures of creativity.

Construct. First, measuring creative interests and attitudes consistently relies on self-reports as measurement approach (e.g., Hocevar, 1981). Creative attitudes can be defined as the degree of positive affect regarding creative dispositions, temperaments, and orientation, and predispose one to think creatively about a product (Davis, 1999). A person who shows creative interests enjoys being involved in creative activities (Slahova et al., 2007). These constructs are not further distinguished from one another as they lack clear segregation based on empirical data. Second, the study of personality investigates individual differences in

behavior and thinking (Kazdin, 2000). Third, the construct of everyday creativity and creative achievement in self-reports describes minor, sometimes major, creative accomplishments in life and/or work (e.g., science) that enrich our everyday lives (Torrance, 1962; Lees-Haley, 1978; Bull & Davis, 1980).

Data Type and Scoring. Self-reports are either based on the data type Q-data (Cattell, 1958) and hence on subjective data or L-data (Cattell, 1958), including biographical data. Q-data approaches are probably the most common form of assessment in psychology due to the ease of item development, scoring, and analysis of Likert-style items. L-data are gathered to describe previous creativity and creative behavior in various contexts based on the participants' introspection and self-evaluation. They can either include multiple-choice items, Likert-scale items (e.g., ranging from “never” to “more than ten times”; Diedrich et al., 2017) or open-ended answers (e.g., “Please name your overall five most creative achievements in your life so far.”, Diedrich et al., 2017). The participants are asked to report the frequency of previous creative actions and performances or provide information about the production of creative things. Q-data probe the participants' typical behavior, whereas L-data indicate skill-related typical behavior or the report of maximal cognitive effort. Skill-related typical behavior includes behavior that requires a high degree of expertise (e.g., playing concert piano), but if this degree of expertise is reached, the behavior is more akin to typical behavior than maximal cognitive effort.

Measures. Table 4 presents all identified self-report questionnaires, including example items. Scales included in creative interests and attitudes are asking for the agreement with a provided behavior (e.g., “When I set goals for myself, I make sure they are open-ended.”; Epstein Creativity Competencies Inventory for Individuals, Epstein et al., 2018). Creative Personality scales are mostly based on adjective checklists (e.g., “Divergent”, Wechsler et al., 2012). In difference to creative interests and attitudes, the creative activities

and achievements are based on biographical information (L-data), such as “how often have you carried out this activity over the past ten years: wrote a blog entry?” (Diedrich et al., 2017). This implies that creative activities and achievements are listed or the number of such events is indicated. Measures, not further listed in Table 4, because they have only been applied in very specific contexts are the Biographical Inventory for Students (Siegel, 1956) and specific workforce measures that have been mostly applied to identify creative personnel (research personnel, Buel, 1965; NASA scientists and engineers, Alpha Biographical Inventory, Institute for Behavioral Research in Creativity, 1968; e.g. Biographical Creativity Predictor for Scientific and Technical personnel, Erickson, Gantz, & Stephenson, 1970; Biographical Inventory Creativity, Schaefer & Anastasi, 1968). Additionally, the Achievement in Leadership questionnaire (e.g., Appointed to one or more offices; Holland & Nichols, 1964) and the Life Experience Inventory (Michael & Colson, 1979) include biographical data on creativity.

Table 4***Self-report Measures***

Measure	Author	Example Items
Creative Interests and Attitudes		
Study of Values	Allport et al., 1960	If you had some time to spend in a waiting room and there were only two magazines to choose from, would you prefer: (a) Scientific Age; (b) Arts and Decorations?
Guilford-Zimmermann Interest Inventory	Guilford, 1963	I often write words in new combinations to convey emotion rather than meaning.
Opinion, Attitude, and Interest Survey	Fricke, 1965	Rules and regulations often do more harm than good.
Rating Scale of Creative Characteristics	Meeker, 1978; Guilford, 1967	Stimulated by reading
Creative Attitude Survey	Schaefer & Bridges, 1970	I get bored easily.
Pennsylvania Assessment of Creative Tendency	Rookey, 1971	Creating new words is dumb.
Creative Behavior Disposition Scale	Taylor et al., 1974; Taylor & Fish, 1979	I combine things in a new way.
How Creative are You? Inventory	Raudsepp, 1981	Daydreaming has provided the impetus for many of my more important projects.
Group Inventories for finding creative talent	Rimm, 1980, Davis & Rimm 1982	I like to make up my own songs.
Efficacy scale for creative productivity	Schack, 1989	I usually work on projects that are not a class assignment if it is about something I am interested in.
Creative Styles Questionnaire	Kumar & Holman, 1989	I typically create new ideas by systematically modifying (by substituting, rearranging, elaborating, etc.) an existing idea.
Creative Assessment Package	Williams, 1993	If the final page of a storybook is missing, I will make up the story's ending myself.
Khatena-Morse Multitalented Perception Inventory	Khatena & Morse, 1994	I have a fluent and vivid imagination which I use in accomplishing tasks.

Abedi–Schumacher Creativity Test	O’Neil et al., 1994; Auzmendi et al., 1996	Approaching a complex task, I come up with a variety of approaches.
Runco Ideational Behavior Scale	Runco et al., 2001	Quality of ideas is more important than quantity.
Creative Self-Efficacy scale	Tierney & Farmer, 2002	I have confidence in my ability to solve problems creatively.
Epstein Creativity Competencies Inventory for Individuals	Epstein et al., 2008	When I set goals for myself, I make sure they are open-ended. (Challenging) I redecorate or rearrange my work environment regularly. (Surrounding)
Cognitive Processes Associated with Creativity	Miller, 2009	While working on a problem, I try to generate as many ideas as possible.
Creative Process Engagement Scale	Zhang & Bartol, 2010	I consider diverse sources of information in generating new ideas.
Kaufman Domains of Creativity Scale	Kaufman, 2012	Finding something fun to do when I have no money.
Creative Cognition Scale in studying	Rogaten & Moneta, 2015	Incorporating previous solutions in new ways leads to good ideas.
Team Creativity Climate	Kiratli et al., 2016	In our team we are open to each other’s views and ideas.
Reisman Diagnostic Creativity Assessment	Reisman et al., 2016	I can generate many solutions.
The Mode Shifting Index	Pringle & Snowden, 2017	When working on a task, I like to think both in depth about the details and drift out of focus and let my mind wander (e.g. looking out of the window).
Creative Personality		
Khatena-Torrance Creative Perception Inventory	Khatena & Torrance, 1976	Using the strategy of restructuring.
Creative Personality Scale	Gough, 1979	Unconventional
Adjective Checklist	Gough & Heilbrun, 1983	Zany
The Creatix Inventory	Byrd, 1986	I am an innovator.
Creative Temperament Scale	Gough, 1992	Inquisitive
Domino Creative Scale	Domino, 1994	Imaginative
Emotional Creativity Inventory	Averill, 1999	I have emotional experiences that would be considered unusual or out of the ordinary.
Creative Personality Scale	Kaufman & Baer, 2004	Love to think up new ways of doing things.
Creative Approach Questionnaire	Durmysheva & Kozbelt, 2010	I begin projects without a detailed understanding of where it will lead me.
Thinking and Creative Styles	Wechsler et al., 2012	Divergent

Short Scale of Creative Self	Karwowski et al., 2018	Creativity is an important part of myself.
Creative Achievements/activities		
Independent Activities Questionnaire	Schultz & Skager, 1963; Skager et al., 1965	Do you sometimes discuss books you have read with friends or family?
Achievement Checklist	Torrance, 1969b	Philosophy of life changed
Accomplishments Measures	Stricker et al., 2001	Wrote a play that was publicly performed or a screenplay for a film that was publicly shown
Creativity Scale for different Domains/ Creativity Domain Questionnaire	Kaufman & Baer, 2004; Kaufman et al., 2010	How creative are you in the area of crafts (for example, wood- working, sewing, repairing things, building things, cooking, etc.)?
Creative Behavior Inventory	Dollinger, 2003	Built a hanging mobile (excluding school or university course work).
Creative Achievement Questionnaire	Carson et al., 2005	I have choreographed dance professionally.
Biographical Inventory of Creative Behavior	Batey & Furnham, 2008	In the past 12 months have you designed and produces a textile product?
Life-Space Questionnaire	Ivcevic & Mayer, 2009	Designed a video game.
Inventory of creative activities and achievements	Jauk et al., 2014; Diedrich et al., 2017, adapted after Hocevar (1979)	How often have you written a blog entry over the past 10 years?

Note. The participant should either rate their agreement on a Likert scale, agree or disagree or indicate how often they participated in the listed behavior. A few items were rephrased. Subscales from personality inventories are not further included for a reference see: International Personality Item Pool; Goldberg et al., 2006; Abridged Big 5 Circumplex (Hofstee et al., 1992; Johnson, 1994), Hogan Personality Inventory (Hogan & Hogan, 1992), Jackson Personality Inventory-Revised (Jackson, 1994), Self-Directed Search questionnaire (Holland, Fritzsche, & Powell, 1997)

Other-Reports

In the following, we describe the measurement approach *other-reports*, by defining its constructs, data-types, and scorings.

Construct. Creative attitudes, characteristics, and divergent thinking are constructs of other-reports (Table 2). Divergent thinking, or as Guilford (1950) labeled it, divergent production, is a cognitive process that produces original ideas in contrast to convergent thinking that results in a single correct answer. More details regarding divergent thinking are provided in the Constructs Section of Ability Tests. Creative attitudes and characteristics can be defined precisely as in self-report measures and are similar in what they measure, with the difference that they are based on significant others' ratings. Another construct assessed by experts (significant others') is ratings of archived products' originality and novelty from eminent persons. In this case, the measure is mostly based on products, actions, and past ideas.

Data Type and Scoring. Within the measurement approach of other-reports we summarize evaluations by peers, parent's reports, supervisor or teacher ratings, but also the ratings of experts that judge the creative amount of a product, performance, or action. The data type for the former includes questionnaire data (describing the typical behavior of a target often post-hoc), while the latter can be seen as L-data as it consists of the ratings of maximal effort of a person. Such expert-based assessments of performances have a long history and are often based on the prominently used CAT (Amabile, 1982). The CAT is based on the idea that the experts consent on the creativity of artwork, creative stories, or research proposals and that this consent is the best measure of creativity (Baer & McKool, 2009). Typically, the participant is aware of the observation (e.g., the participant is applying for an award, attending a competition).

Measures. The measures we have identified as other-report measures are presented in Table 5. Table 5 includes measures of creative attitudes and interests that are, similarly to measures of reported divergent production, mostly completed by parents and teachers. Other measures are focusing on the other-reported employee creativity (e.g., Ng & Feldman, 2012). A meta-analysis identified 86 studies, of which 60% included some supervisory ratings of creativity and five percent peer ratings. Even though such ratings are applied and creativity is of high value for companies, explicitly published measures for this purpose are sparse (e.g., Baer & Oldham, 2006; Madjar, Ortiz-Walters, 2008; Zhou & George, 2001). The post-hoc evaluation and study of eminent people is one of the first attempts to measure and understand creativity and was applied before most other creativity measures. Analyzing archival data of eminent people provides insight into the creative process. Most eminent people have produced numerous ideas and outcomes, with only rare breakthroughs sometimes driven by luck and chance (e.g., Pasteur or Nobel; Cropley, 2006). Simonton referred to the analyses of historic individuals in his prominent historiometric approaches (Simonton, 1999). Historiometric approaches often include the quantity and the quality of creative productions. This has also led to several indices, such as the strict equal-odds, to study real creative outcome in terms of a linear function of quantity (e.g., Forthmann et al., 2021). Table 5 includes examples of ratings of archival data of eminent/historic people. For example, Cattell's (1903) study is based on rank-ordering the most eminent people based on the number of words written about the people in various biographical dictionaries. Based on this idea, the most creative architects, writers, biologists, and mathematicians were selected.

Table 5
Other-report Measures

Measure	Author	Example Item
Creative Attitudes and Characteristics		
Parental Evaluation of Childrens Creativity	Runco, 1989	To what extent is this child imaginative?
Creative Assessment Package	Williams, 1993	My child has a vivid imagination.
Rating the Behavioral Characteristics of Superior Students	Renzulli et al., 2002	The student demonstrates creative thinking about scientific topics
Gifted and Talented Evaluation Scales	Gillian et al., 1996	The student demonstrates enthusiasm in discussions of scientific topics
Ideal Pupil Checklist	Torrance, 1975	What kind of person is ... e.g., determined
Creative Behavior Inventory	Kirschenbaum, 1989	This child notices and remembers details.
Divergent Thinking		
Characteristics of Creative Children	Reid et al., 1959	My classmate has new ideas and new ways of doing things.
Creative Dramatics Test	Hensel, 1973	The child has creative thinking abilities.
Gifted and Talented Screening Form	Johnson, 1979	The child is talented in creativity.
Creativity checklist	Johnson, 1979	The child has a preference for complexity.
Preschool and Kindergarten Interests Descriptors	Rimm, 1983	My child tends to be very curious.
Leadership and Employee Creativity	Tierney et al., 1999	The employee took risks in terms of producing new ideas on the job.
Supervisor-ratings of Creativity	Zhou & George, 2001	Suggests many creative ideas that might improve working conditions.
Archival Data		
Overall eminence	Cattell, 1903	Rank-ordering the 1,000 most eminent people.
Physical scientists	Roe, 1951	Rating the excellence of physical scientists on a three-point scale.
Leaders	Barron, 1969	Selecting and studying leaders in Irish Economic life.
Architects	Hall & MacKinnin, 1969	Identifying and studying the 40 most creative architects in the United States.
Math	Helson & Crutchfield, 1970; Helson, 1971	Identifying the most creative researchers in math and studying their achievements.
Engineering	Chakrabarti, 2013	Studying the innovations of engineering designers and innovators.
Sports	Martin & Cox, 2016	Analyzing the moves of a basketball player.

Note. Ordered by publication year. A few items are reframed. For a more detailed overview of the study of eminent people until 1979, see Hovecar (1979)

A further construct assesses the originality of outcomes (e.g., performances). Such measures are not further included in Table 5 but will be shortly summarized in the following. Typically, such expert ratings can involve indices of productivity (e.g., originality of ideas involving the US. Patent Index; Owens et al., 1957), that are used to assess employee creativity (Tierney et al., 1999). One scale explicitly designed for rating peak creativity in vocational but also avocational outcomes of others is the Lifetime Creativity Scale that provides several definitions in order to rate the levels of peak creativity (Richards et al., 1988). Besides, originality is often assessed in visual arts and poems (Cattell et al., 1918; Brittain & Beittel, 1964; Csikszentmihalyi & Getzels, 1970; Baer et al., 2004) or science (Harmon, 1963; Taylor et al., 1963). For example, competitions often include a judgment of originality and novelty (e.g., NYC radio contest: submit a humorous and original little green thing; Ward & Cox, 1974). Judgments of product originality and novelty can also take place in school (e.g., mathematics and literature, Foster, 1971; creativity in writing, Wallen & Stevenson, 1960). The above-described evaluations such as stories, art, poetry, and aesthetic products (Amabile, 1982; Horn & Salvendy, 2006; Cropley & Kaufman, 2012; Jeffries, 2017) are rater-based assessments of creativity. The later examples, such as Baer and colleagues (2004) mostly apply the CAT technique (Amabile, 1982; Cseh et al., 2016) to assess product creativity in various domains (please note that an exhaustive list of CAT applications is beyond the scope of this article). Another scales for the judgment of work pieces is the Creative Solution Diagnosis Scale (Cropley & Kaufman, 2012) that is applied for judging artworks, cartoons, t-shirts, novel chairs, and advertisements (Besemer & O'Quin, 1986, 1987, 1999; White et al., 2002) and even mouse-trap designs. Further scales are the Creativity Product Inventory (Taylor & Sandler, 1972; Taylor, 1975), Creative Product Semantic Scale (O'Quin & Besemer, 1989, e.g., a product is surprising and germinal), Student Product Assessment Form (Renzulli & Reis, 1981), and the

usability assessment in the area of technological and scientific products (Han et al., 2000; Cropley & Kaufman, 2012).

Ability Tests

In the following, we describe the measurement approach *ability tests*, by defining its constructs, data-types, and scorings.

Construct. The application of ability tests in assessing creativity arguably began as part of the United States Army Air Force Aviation Psychology Program (Guilford, 1947). It continued in Guilford's Aptitudes Project carried out at the University of Southern California (Guilford et al., 1952). Guilford's 1950 Presidential Address to the American Psychological Association (Guilford, 1950) is often considered a turning point and strongly influenced the way creativity was perceived. Wilson and colleagues (1954) administered 53 tests and ran a factor analytic study of primary abilities, such as the constructs of fluency, flexibility, and the production of novel ideas, a few years later. This resulted in 46 different divergent thinking tests categorized by 14 constructs of creative thinking ability that are not further referred to in this review (a complete list of these measures is provided in the Ability Tests Measure section). Please note, as pointed out by an anonymous reviewer, earlier work on the measurement of originality went unrecognized by Wilson and colleagues but that earlier work had suggested similar measurement approaches (see Chassell, 1916). Later, Guilford (1956, 1986) claimed that divergent thinking is comprised of fluency (quantity of adequate responses), flexibility (number of category switches between responses within a task), originality (classifying the rarity, cleverness, and originality of a response within a sample), and elaboration (amount of details given in an answer). Nevertheless, divergent thinking tests cannot be easily subdivided by fluency, flexibility, and originality. These aspects represent scoring methods, and many tests are scored on more than one dimension (e.g., originality and quantity of named things; Carroll, 1993).

Besides divergent thinking, the other creativity construct in ability measures includes insight performance in creative problems (Polya, 1945). Insight describes the process of solving a problem (Mayer, 1995) and has often been related to major scientific discoveries and creativity (Cropley, 2006; Finke, 1995). Many insight problems (i.e. Duncker's candle problem) have their origin in earlier gestalt-psychology. Insight is only involved when solving novel and non-routine problems and includes a shift of perspective (Dow & Mayer, 2004). This shift of perspective and discovering new ideas are also referred to as the *Eureka* moment (Vallée-Tourangeau, 2018; Sprugnoli et al., 2017). Insight tasks are often employed as creativity tasks (e.g., Gibson et al., 2009; Martindale et al., 1984). They are meant to facilitate creative solutions because of their nature of linking remote ideas or words (Mednick & Mednick, 1967).

Data Type and Scoring. In most divergent thinking tasks, participants are asked to generate ideas or react to a spatial or verbal prompt (Kim, 2006). The tasks are used to gather objective test-data by subjects providing open-ended responses. The behavior measured here is maximal cognitive effort. Performance on insight tasks is usually expressed as the proximity to a pre-defined solution. Insight tasks can be verbal, mathematical, or spatial problems that are all featured by one correct answer. Hence, they are often scored as the participants' proportional attainment of an objective response standard.

Measures. Many divergent thinking tests go back to the tests Wilson and colleagues have proposed (1954). Unfortunately, earlier tests as proposed by Chassell (1916) are buried in oblivion. Chassell (1916) proposed twelve originality tests that also show similarities to later developed tests (e.g., such as coming up with economic prophecies or novel situations). The tests presented by Chassell show some similarities with later proposed insight tests. However, these tests have open response format and provide credit to more than one solution. Therefore, we classify them as divergent thinking tests. The tests presented later on by Wilson

included, for example, Brick Uses/Unusual Uses ("List different uses for a brick."), Consequences Test ("List consequences of certain changes."), and Plot Titles ("Write titles for story plots: fluency score/originality score."). The tests include verbal, numerical, or spatial content. For an exhaustive list of measures (including earlier measures of Chassell, 1916), please see the list provided in the OSF. In Table 6 we present a variety of general divergent thinking tests developed after Wilson et al. (1954), mostly applied for adults (please note divergent thinking tests for specific contexts (e.g., music) or groups (e.g., children) are described in the later text sections).

Table 6

Ability Tests: Divergent Thinking Spatial and Verbal for Adults (after Wilson et al., 1954)

Measure	Author	Example Items
Consequences Task	Christensen et al., 1958	Imagine that people no longer needed to sleep. What would happen as a consequence?
Test of Creative Ability	Industrial Relations Center, 1959; Harris & Simberg, 1959	List all possible uses for an ordinary wire coat hanger.
Alternate Uses Task	Christensen et al., 1960	List all the different ways you could use a chair.
Line Meanings	Tagiuri, 1960	What does this line make you think of?
Minnesota Tests of Creative Thinking and Writing	Yamamoto, 1964	What questions can you think about the things you see in the picture?
Instances Task	Wallach & Kogan, 1965	Write down all of the unusual, creative, and uncommon instances of things that are round.
Wallach-Kogan Test	Wallach & Kogan, 1965	Tell me all the ways in which an apple and orange are alike. (Similarities)
Torrance Test of Creative Thinking	Torrance, 1966	What might this picture show?
Plot Titles	Berger & Guilford, 1969	Provide appropriate titles for a story.
Incomplete Figures	Torrance, 1969a	Complete a given figure.
Picture construction from dots	Torrance, 1969a	Construct a picture out of dots.
Comprehensive Ability Battery	Hakstian & Cattell, 1975	Generate ideas and alternative uses in applied arts, sales, marketing, consulting, and teaching.

Combining Objects	Ekstrom et al., 1976; French et al., 1963	Name two objects, when used together, fulfill a particular request.
Substitute Uses	Ekstrom et al., 1976; French et al., 1963	Think of a common object that could serve as a substitute for a given purpose.
Making Groups	Ekstrom et al., 1976; French et al., 1963	Combine given items in a group and provide a reason for grouping them.
Different Uses	Ekstrom et al., 1976; French et al., 1963	Provide other uses for a magazine.
Toothpicks Test	Ekstrom et al., 1976; French et al., 1963	Make different patterns of squares outlined by toothpicks.
Planning Patterns	Ekstrom et al., 1976; French et al., 1963	Fit figures onto a group of dots.
Storage Test	Ekstrom et al., 1976; French et al., 1963	Store objects in a given space.
Word Endings Test	Ekstrom et al., 1976; French et al., 1963	Write words that are ending in ATE.
Word Beginnings Test	Ekstrom et al., 1976; French et al., 1963	Think of words that are beginning with RE.
Word Beginning and Ending Tests	Ekstrom et al., 1976; French et al., 1963	Think of words beginning with S and ending with N.
Opposites Test	Ekstrom et al., 1976; French et al., 1963	Try to think about some words which mean the opposite of the word easy.
Controlled Associations Test	Ekstrom et al., 1976; French et al., 1963	Write as many synonyms for the word short.
Figure of Speech Test	Ekstrom et al., 1976; French et al., 1963	Try to think about words and phrases that complete the figure of speech: the jewels sparkled like...
Making Sentences	Ekstrom et al., 1976; French et al., 1963	Write a sentence contain words that begin with the letters E – R – T
Arranging Words	Ekstrom et al., 1976; French et al., 1963	Write sentences containing the words TAKE – FEW – LAND – LITTLE
Rewriting	Ekstrom et al., 1976; French et al., 1963	Rephrase the sentence “In response to the teacher’s question, a forest of hands shot up.”

Ornament Test	Ekstrom et al., 1976; French et al., 1963	Decorate a plain lampshade in different ways.
Elaboration Test	Ekstrom et al., 1976; French et al., 1963	Add details on a playing card.
Symbols Test	Ekstrom et al., 1976; French et al., 1963	Draw symbols that represent the word food.
Topics Test	Ekstrom et al., 1976; French et al., 1963	Write as many ideas you can think of about “A train Journey”.
Theme Test	Ekstrom et al., 1976; French et al., 1963	Write a paragraph about the theme “a tree”.
Thing Categories Test	Ekstrom et al., 1976; French et al., 1963	List things that are always red or that are red more often than any other color.
American Haiku	Amabile, 1985	Write a five-line, unrhymed poem, following a series of steps.
Emotional Consequences	Averill & Thomas-Knowles, 1991	What would happen if people would fall in love with a different person every day?
Creative Assessment Package	Williams, 1993	Incomplete Figures that must be completed by drawing. Come up with a title for each drawn figure.
Word rearrangement test	Fillis & McAuley, 2000	Construct a story that contains as many of the presented words as possible.
Aurora Project	Chart et al., 2008	Imagine that the world changed so that almost everything can speak. Write a little conversation describing what the two things listed might say to each other if they could talk. Each thing must say at least one thing. Before you write what they will say, circle who is speaking.
Situational Originality	Antonietti et al., 2011	Choose three things, between the listed words to describe a tennis game.
Kaleidoscope Project	Sternberg, 2012	Share a one-minute video that says something about oneself.
Cued Creativity Verb Generation Task	Prabhakaran et al., 2014	Say a creative verb that is related to the noun scissors.

Note. Tests are ordered by publication year. A few items are rephrased.

One very prominent divergent thinking test, included in Table 6, is the Torrance Test of Creative Thinking (Torrance, 1966). The test includes verbal (e.g., “Improve products”) and spatial subtests (e.g., “What might this picture show?”), that are combined in one sum score. The test is based on fluency, flexibility, and originality aspects of creativity. It includes

verbal subtests such as asking, guessing causes, guessing consequences, product improvement, unusual uses, unusual questions, and spatial subtests such as picture construction, picture completion, and lines and circles. The spatial test is assumed to be a culture-fair instrument as it is only based on minimal language. In a 50-year follow-up longitudinal study, the scores obtained in late 1950 were correlated to current personal and public achievement. It was found that these scores were moderately correlated with personal achievement, but not with public achievement (Runco et al., 2010).

There are a number of tests that are not included in Table 6, as they are rather specific. This includes measures that assess creativity in art and music: The Denny-Ives Creativity Test (e.g., redefinition in dramatic art; Rusch et al., 1964); Hall Mosaic Construction Test (Hall, 1972), spatial creativity and alien drawing (Niu & Sternberg, 2001), Measure of Creativity in Music and Sounds (Baltzer, 1988), Measures of Musical Divergent Production (Gorder, 1980; Richardson & Saffle, 1983), Onomatopoeia and Images (Torrance et al., 1973), Thinking Creatively with Sounds and Words (Torrance et al., 1973, Houtz, 1985), Musical Expression Test (Barbot & Lubart, 2012), Creative Thinking in Music (Webster, 1994), and Musical Originality (Coffman, 1992). Test not included in Table 6, as they are specifically for the occupational context are: Owens' Creativity Task for Machine Design (Owens, 1960), Purdue Creativity Test (e.g., generate flexible ideas to solve job-related problems, Lawshe & Harris, 1960), Creative Engineering Design Assessment (Charyton & Merrill, 2009), Formulating Hypotheses Test (Frederiksen et al., 1975), and The Scientific Word Association Test (Gough, 1975; Gough 1976). Lastly, we describe we summarize specific divergent thinking tests for children, that were also excluded from Table 6: Divergent Movement Ability Test (Cleland, 1994), Thinking Creativity in Action and Movement (Torrance & Gibbs, 1977), Starkweather Creativity Tests available for pre-school children (Starkweather, 1971), the Purdue Elementary Problem Solving Inventory (Feldhusen et al., 1972), the Gross Geometric

Forms Test (Gross & Marsh, 1970), and the originality of forms test that consists of three-dimensional abstract forms (Starkweather, 1974). The Barron-Welsh Art Scale is a Freudian-based assessment in which the participant is asked to draw a picture. The pictures are scored on various scales, including personal styles and social attitudes (Welsh & Barron, 1959). The Test for Creative Thinking-Drawing Production (Jellen & Urban, 1989) uses a set of eleven criteria to assess the creativity of a drawing produced by elementary school children. Other tests that have been applied in the school context are the Creative Reasoning Test (Doolittle, 1989) and the Evaluation of Potential Creativity (Lubart et al., 2011). A more recent approach for measuring scientific creativity in children is the Creative Scientific Ability Test (Ayas & Sak, 2014). The test measures fluency, flexibility, hypothesis testing, generation, and evidence evaluation in five subtests that are allocated to the fields of Biology, Interdisciplinary Science, Chemistry, Physics, and Ecology.

The second construct in ability tests includes creative insight problems. In classic insight problems, the participant is asked to provide one correct solution. Historically, Gestalt-psychological problems were used to study insight performance (e.g., Köhler, 1967). Insight has been traditionally studied with problems such as the *Nine-dot Problem*, the *Dunker Candle Task*, and the *The Triangle of Coins* (for an overview, see Chu & MacGregor, 2011). Besides these classic insight tasks, Chu and MacGregor (2011) also reviewed newer insight problems, such as Matchstick Arithmetic (Knoblich et al., 1999), Compound Remote Associates (Bowden & Jung-Beeman, 2003), or Remote Associate Tasks (Mednick & Mednick, 1967) or Rebus Puzzles (MacGregor & Cunningham, 2008). In the *Remote Associate Task*, the participants are asked to produce a remote associate to a given word. Other typical insight problem tasks are anagrams (Novick & Sherman, 2003) and riddles (Luo & Niki, 2003) as a measure of word imagery representing verbal problems (Dewing & Hetherington, 1974). Word analogies have also been assessed together with different

instructions (such as “Think more creatively about whether the four-word set constitutes a valid analogy.”, Green et al., 2012). Another verbal task is the brainteaser (Sheth et al., 2009), while the binarized images (Giovannelli et al., 2010) are task-based on pictorial stimuli. All these tasks are also described in Sprugnoli and colleagues' (2017) and Chus and MacGregors' (2011) review of human performance on insight tasks. A further, more recent test is the Design Thinking Creativity Test (Hawthorne et al., 2016) that presents problem-solving skills within the twenty-first century and is based on design thinking principles. Here the individuals must develop a “useful and meaningful” design solution (Plattner et al., 2015).

Psychometric Problems of the Measurement Approaches

In the next sections, we complete the application of our taxonomy by presenting psychometric shortcomings of each measurement approach.

Self-Reports

Self-report measures are susceptible to several sources of bias—social desirability, reference and response style biases. In the assessment of creativity, individuals' introspection might be problematic (e.g., Baas et al., 2015). There has been much effort in the development of creativity self-report measures within the last few years (e.g., Forgeard & Kaufman, 2015; Kaufman, 2019; Silvia et al., 2012), and recent measures often show acceptable to good reliability (e.g., Revised Creative Domain Questionnaire: $\alpha = .82$; the Biographical Inventory of Creative Behaviors $\alpha = .74$; Silvia et al., 2012). However, reliability as estimated by Alpha reflects consistency in responding, and that consistency can be inflated by the consistency of biases. A way to get around this is by considering correlations with non-self-report measures of creativity. However, there seems to be a general problem of convergent validity given the low correlations often found between tests of divergent thinking and self-report measures (e.g., $r = .16$; Kandler et al., 2016). Such low correlations suggest that different constructs are

measured or severe reliability problems are an issue with at least one of the two constructs. Besides, self-reports are prone to various self-report biases (e.g., social desirability, acquiescence, malingering, etc.). As mentioned above, the self-report measures (Q-data and L-data) reported in our review require some amount of introspection of the individual. This can be problematic as individuals may understand the question, item, or response options differently (Weiss & Roberts, 2018) or show an incongruence between their beliefs regarding creativity and the actual scientific evidence (Baas et al., 2015). This can lead to low reliability of a self-report scale and low convergent validity with ability measures. This leads to the question of how well an individual (or others') can rate themselves (or others') on a self-report if researchers are still struggling to define and understand creativity. Another vital issue displayed in self-reports (especially the Q-data) is that the fixed choice questions lack flexibility and force people to respond. Many Q-data items are not in line with the bipartite nature of the definition of creativity, as they are very specific and often do not meet the definition.

Furthermore, these items lack a real test of the people's ability to be original and fluently produce novel ideas. The measures that are identified as Q-data are also not easy to distinguish from other close constructs. For example, there might be a substantial overlap between personality self-report and creativity self-report items. This overlap is further described in the discussion. Hence, practitioners must use these items carefully to avoid jingle-jangle fallacies. The measures, including L-data, also require introspection regarding an extended period, and some participants might not be able to report any creative achievements.

Other-Reports

Other-reports are common across student and class evaluation by teachers, peers or parents, and the workplace (e.g., supervisor-ratings). Ratings can be based on various events and situations, and the raters can have different expertise and biases. Drevdahl (1956) showed

that teachers' nominations were not significantly different when the teachers were given a clearly defined concept of creativity and were clearly instructed. However, parents' ratings are often only weakly related to teachers' ratings of the students' creativity (Runco, 1989). Meta-analytic studies provide evidence that the frequency of interaction with the target and especially interpersonal intimacy is necessary to substantially increase the accuracy of other-rating on personality (Connelly & Ones, 2010). Besides, the data of human raters are intrinsically nested. Such nestedness and the effects of the human coding should preferably be part of the statistical modeling, as, applied in specific item response theory models, that account for item and rater-characteristics (e.g., Robitzsch & Steinfeld, 2018).

Other-reports are often highly domain-specific and there are several reasons why ratings of others can diverge. As such discrepancy between any kind of raters can be due to differences in the construct understanding or even domain expertise (e.g., Amabile, 1996), it is important that standardized instructions for raters are applied as well as standardized test material (e.g., the granularity of the Likert-scale; Cseh & Jeffries, 2019). In conclusion, all other-ratings can be psychometrically problematic if the rater is not familiar with the target (e.g., the person or the rated creative outcome) or the rated construct. However, assessing eminent people by the fluency or the originality and novelty of products is a promising approach.

Ability Tests

Divergent thinking tasks are the most prominent tasks in measuring creativity and the tasks that have arguably better validity, reliability, and predictive power for relevant outcomes. One of the major challenges comes with scoring of divergent thinking tasks (e.g., Cseh & Jeffries, 2019). First, the scoring should be in line with the instruction. This implies that the participants should be only scored on the dimension that was instructed and measured (e.g., a task in which participants were instructed to be fluent, their fluency and nothing else

should be the target of the performance appraisal, while tasks that ask for an original answer should evaluate performance according to originality standards). Second, free-response formats requires some human judgments. The relevance of these judgments can be part of the response modeling (e.g., see Robitzsch & Steinfeld, 2018 for models that account for different rater characteristics). The next challenges arise when it comes to the dimension (e.g., originality) of the score that is derived from the data (for an overview see Reiter-Palmon et al., 2019). Fluency scores that are easy to derive can be criticized concerning their dependability on the ability to retrieve information (e.g., broad retrieval ability highly predicts creative fluency, Silvia et al., 2013). Flexibility scores are often based on arbitrary classification systems that have varying granularity of categories. Originality scores can be problematized with regard to the lack of generally recognized standards and protocols, and more often than not for the low agreement between raters. Another general shortcoming that is not further related to the scoring issues described above is that most divergent thinking tasks are time-constrained and based on verbal or spatial expressions. This indicates that general intelligence and cognitive speed are relevant sources of variance although that may not be intended. In order to overcome some of these issues, Forthmann and colleagues (2017) described modern approaches for scoring divergent thinking tasks, including computerized frequency scorings, associational remoteness based on latent semantic analysis, and a snapshot scoring for cleverness based on three human raters (e.g., Silvia et al., 2009).

Insight tasks are easy to score, but there is a question about their relation to creativity. Insight tasks require a correct response, but there is no possibility of assessing a person's novelty or originality. It may be challenging to evaluate details of response processes a person was applying to solve the problem. The convergent nature of insight tasks—one veridical answer—questions their applicability of creativity tasks and their detachability of typical convergent thinking (aka intelligence) tests. In fact, famous insight tasks, such as the Remote

Associate Task (Mednick & Mednick, 1967), are used to assess both convergent thinking and divergent thinking. Therefore, some researchers argue insight is an important part of creativity (e.g., Weiss et al., 2020), while others describe no correlations with creativity but rather with intelligence and motivation (e.g., Shaw & Conway, 1990).

Creativity Measures: Construct Validity

Based on the vast range of measures embedded in our taxonomy, we must ask whether all these measures really assess a coherent dispositional trait best labeled as creativity. Similarly, it has to be asked if there is at least some coherence regarding the dispositional trait within the constructs. Situations in which different phenomena are subsumed below the same label are referred to as *jingle fallacies* (Thorndike, 1904). For example, self-reported creative activities and achievements are highly correlated with other creative achievement self-reports ($r = .68$; Jauk et al., 2014), which can be taken as proof of convergent validity. On the other hand, creative activities are only weakly predicted by fluency ($\beta = .22$) and originality ($\beta = .25$), and the relation between creative achievements and fluency/originality was mediated by creative activities (Jauk, et al., 2014). This study therefore consequently distinguishes between divergent thinking measures, creative activities, and creative achievements as they do *not* measure the same underlying construct. Nevertheless, the literature often presents results regarding *creativity* that do not distinguish between the substantial differences associated with the measurement approaches and constructs.

Assigned to our taxonomy, this situation would indicate that all measures proposed as creativity measures should be related to one another – i.e., they should demonstrate a positive manifold. If this positive manifold is not confirmed, we would, at the very least, recommend relabeling variables of interest to indicate that they do not measure the same underlying construct. Additionally, other things being equal, any two creativity measures should be correlated more highly with each other than with non-creativity indicators. For example, the

correlation between two creativity indicators should, in general, be stronger than that between creativity and an intelligence task. This aspect of construct validity can be evaluated through Multi-trait-Multi-method (MTMM) analysis; Campbell & Fiske, 1959), which separates format or method (e.g., Likert-scale vs. performance test) from construct or trait (e.g., creativity vs. intelligence). The taxonomy we propose suggests factors that might be considered to conduct such analysis. Available findings help to address what might emerge from such analysis. In various studies, no substantial or high correlations have been found between measures of typical behavior (assessed with self-reports) and maximal cognitive effort (assessing abilities). The literature provides several examples of the little-to-no correlation between indicators (e.g., other's reports that are only weakly related with one another and unrelated with self-report (Richards et al., 1964; Taylor et al., 1963), creativity self-reports that are only weakly or not related with divergent thinking (Clapham, 2004). These weak correlations endorse the conclusion that measures of both behaviors assess distinct features.

We recommend 1) that creativity indicators should only bear the same label if they are highly related with one another and 2) a strict and careful use of labels and theoretical approaches that further describe the similarities and differences between indicators. We believe that this application would prevent further research results published under the same label. In sum, avoiding or carefully considering *jingle fallacies* would shed more light on creativity as a construct and its true nature. Besides, we recommend the use of divergent thinking tests. As measured with divergent thinking, the importance of originality is already made clear by the definition of creativity. Originality is a key attribute of creative products and can be measured best in a test situation and product/idea evaluation.

This guideline becomes even more important when so-called proxy variables are applied to gather indicators of creativity. As outlined above, measuring creativity suffers from

jingle fallacies. This issue becomes more problematic when applied measures tap into different constructs. Measuring creativity with different constructs comes along with several drawbacks. However, we recognize the importance of such proxy measures for research as these measures might help enlarge the nomological net of creativity. Besides, using proxy variables for creativity is reasonable if the correlation between the proxy variable and the targeted aspect of creativity is very strong. For example, the assessment of creativity in the sense of self-reported preferences, based on openness measures has been justified by its positive relation with creativity (McCrae, 1987).

Taken together, we recommend assessing creativity based on validated multivariate measures. However, multivariate studies allow considering different measures and even proxy variables; thus, they are worth studying to shed more light on the nomological net of creativity and related constructs.

Although the taxonomy classifies different measures based on attributes, this does not strongly imply converging validity evidence across methods for assessing creativity. This result is due to the heterogeneity in conceptualizations and measurement approaches. In other words, at this stage, it is not possible to guarantee the validity of individual indicators to deliver valid measures of the cell within which they are placed. Therefore, we recommend a careful selection of creativity measures in line with the definition and the intended construct.

All things considered, we recommend the application of divergent thinking for assessing an individual's creativity. Although several psychometric problems must be considered, divergent thinking measures deliver results showing the smallest discrepancy between the construct definition and the scope of measures. Future research should address the remaining deficiencies of divergent thinking measures – many of which relate to the scoring of divergent thinking tasks (e.g., Reiter-Palmon et al., 2019). These deficiencies include the dependency between originality and fluency (Barbot, 2018; Forthmann et al.,

2018), stimulus dependencies (Barbot, 2018), and the relevancy of task instructions (Nusbaum et al., 2014). These psychometric problems can be addressed by applying a broader range of tasks that are carefully and congruently instructed, analyzed, and scored (Reiter-Palmon et al., 2019). Multivariate studies including such a broad task range (e.g., Runco Creativity Assessment Battery offers a selection of divergent thinking tasks also complemented by experimental approaches (3-D divergent thinking), self-reports, and even other's reports; Runco, 2011) can lead to better generalizability and hence foster the understanding of individual differences in creativity. Test development can also benefit from interdisciplinary work, including neuropsychological research (Benedek et al., 2019) and trials (such as the Multi-Trial Creative Ideation; Barbot, 2018).

In sum, although divergent thinking tests are the most widely applied indicators, there has generally been little progress in divergent thinking test development since the 1960s. In the following, we, therefore, describe perspectives for future creativity research, also including measurement development.

Perspectives in Future Creativity Research

There is a variety of prospects for creativity research. Here, we want to focus on two avenues: a) enlarging the nomological net of creativity and proximal constructs, and b) providing inspiration for novel creativity measures. First, creativity is studied for over a century, but there is still a surprising gap regarding multivariate studies exploring the validity and relationship between the measurement approaches, including related constructs. For example, only a few studies include achievement measures and self-reports of creative interest and divergent thinking measures of fluency and originality (e.g., Jauk et al., 2014). Nevertheless, such extensive multivariate studies are necessary to improve our understanding of what creativity is and its relation to neighboring constructs/proxies. To better understand what creativity is, it is also worth studying if creativity should be further differentiated. This

endeavor can be pursued by studying constructs that are supposedly highly similar—measurement-wise and theoretically—to creativity. One example of such a construct is emotional creativity that should be further studied in relation to and differentiation from creativity (e.g., Ivcevic et al., 2007).

Concerning the second avenue, we need to acknowledge that for a long time creativity measures, especially divergent thinking tasks, have not improved much. However, recently new and interesting developments (e.g., implementing new technologies; Guegan et al., 2017), digitalization (e.g., digital CAT; Cseh et al., 2016) and scoring methods (Beaty & Johnson, 2021; Reiter-Palmon et al., 2019) have been proposed. Still, a lot of currently applied divergent thinking tasks are often alterations of tasks that were originally suggested in the 1950s (e.g., Wilson et al., 1954). Despite the remarkable developments in several technologies, the literature on providing new approaches to pioneering ability tests is still sparse. Such technologies, for example, virtual realities, provide researchers with the opportunity to measure creative ability within a context that can be closer to real-life settings or contextualized fictional worlds than standard divergent thinking measures can provide. Virtual reality offers the chance to perform creatively and interact with other players within prespecified settings. We argue that behavior in gamified settings might be a promising avenue to capture novel aspects of creative potential. Apart from that, the data that can be derived from such settings might offer other intriguing ways of scorings that do not, or only partly, require human judges. Taken together, we believe that the development of divergent thinking settings (for individuals and groups) within such technologies could greatly further the understanding of creativity.

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