Assessment of real-life creativity: The Inventory of Creative Activities and Achievements (ICAA)

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Diedrich, J., Jauk, E., Silvia, P. J., Gredlein, J. M., Neubauer, A. C.; Benedek, M. (2018). Assessment of real-life creativity: The inventory of creative activities and achievements (ICAA). *Psychology of Aesthetics, Creativity, and the Arts, 12*(3), 304-316. http://dx.doi.org/10.1037/aca0000137

Abstract:

This article introduces the Inventory of Creative Activities and Achievements (ICAA), a broad-based assessment of individual differences in real-life creativity. The ICAA provides independent scales for the frequency of engagement in everyday creative activity and the level of creative achievement across 8 creative domains. A formal test analysis based on 7 Little-C samples and 2 Pro-C samples (overall N = 1,566) provides evidence for the reliability and validity of the ICAA test scores. The analyses shed light on the prevalence of specific creative activity and achievement and examine the relevance of personality, creative potential, and intelligence across domains of creativity. The findings further suggest that the assessment of creative activity is particularly suited for Little-C creativity, whereas the assessment of creative achievement appears more appropriate for Pro-C creativity. The ICAA offers researchers a broad and versatile assessment tool for studying creativity across domains and levels.

Keywords: creativity | creative activity | creative achievement | meta-analysis

Article:

How do individual differences in personality, cognitive ability, expertise, and environmental factors contribute to real-life creativity? The successful investigation of these central questions crucially depends on how well we can actually measure real-life creativity—an issue well known as the *criterion problem* in creativity research (Runco, 2009; Shapiro, 1970). The assessment of real-life creativity is particularly challenged by the vast range of possible creative expressions and products. One person is deemed creative for sewing a bag using his worn-out jeans, another one for winning the Pulitzer Prize. Real-life creativity can vary substantially with respect to the level of public acknowledgment (i.e., personal vs. public achievements; Runco, Millar, Acar, & Cramond, 2010) as well as with respect to the domain in which it is accomplished (e.g., handcraft vs. literature).

Regarding the level of real-life creativity, a useful distinction is to discriminate between Little-C, Pro-C, and Big-C creativity (Kaufman & Beghetto, 2009). Little-C creativity refers to everyday creativity people engage in for fun in their leisure time (e.g., creating original presents, knitting a scarf, or jamming with friends). Pro-C creativity refers to professional levels of creativity, usually coming from people with some degree of formal training and expertise (e.g., releasing a music album, having an exhibition, or holding a patent). Pro-C products receive some public acknowledgment, but usually only within specifically interested audiences. Big-C creativity refers to accomplishments from eminent creators: people who gained global acknowledgment or eternal fame for their revolutionary achievements. Research on these different levels of creative achievement may require different measures for creativity assessments (Kaufman & Beghetto, 2009).

Standardized measures of real-life creativity usually present lists of relevant creative accomplishments and then take one of two approaches: They either ask for the frequency of creative activity (Little-C) or for the attained level of creative achievement (Pro-C; Silvia et al., 2012). The former measures quantify the amount of creative activity in terms of how often a person engages in diverse creative activities. The latter measures focus on publically noted creative achievements and attempt to estimate their status within their creative domain. This can be measured in terms of subjective ratings or objectively (e.g., money earned by-products) or by a fixed ranking (e.g., selling a piece of work indicates higher creativity than participating in a group exhibition; Carson, Peterson, & Higgins, 2005). Generally, measures of creative activity seem to be more appropriate for assessing Little-C creativity, whereas measures of creative achievement may be more appropriate for the assessment of Pro-C creativity.

Obvious issues in this field relate to the question of how to provide a comprehensive assessment of real-life creativity covering a broad range of achievements and domains. We constructed the Inventory of Creative Activities and Achievements (ICAA; available in German and English at https://osf.io/4s9p6/) to measure creative activity and achievement in a balanced way across the most relevant creative domains. In this article, we present data from nine independent studies using the ICAA, including two Pro-C samples. Based on the available data, we provide a psychometric examination of the ICAA items and scales and examine evidence for its scores' validity in terms of relationships between relevant trait measures and real-life creativity.

The Assessment of Creative Activity

Individual differences in creative activity (CAct) are commonly assessed by asking how many different creative activities a person has been engaged in (e.g., "written a short story"). CAct reflects a quantitative aspect of how often a person is engaged in creative pursuits, but not necessarily the public awareness of this engagement. Available questionnaires include the *Creative Behavior Inventory* (CBI; Hocevar, 1979; revised version by Dollinger, 2003) and the Biographical Inventory of Creative Behavior (BICB; Batey, 2007). The CBI requires to indicate how frequently (*never* to *more than 5 times*) each of 90 activities (e.g., "wrote poetry") has been performed within adolescence and adult life. The BICB asks for the frequency of involvement in 34 activities within the last year. Both scales display high levels of internal consistency ($\alpha > .90$; Silvia, Wigert, Reiter-Palmon, & Kaufman, 2012) and yield a total score of CAct. The Kaufman Domains of Creativity Scale (K-DOCS; Kaufman, 2012) takes a slightly

different approach. It presents 50 activities (e.g., "Finding something fun to do when I have no money") and asks for a self-evaluation of creativity compared with peers (*much less creative* to *much more creative*). The K-DOCS was shown to be internally consistent ($\alpha >$ .80; Kaufman, 2012).

The Assessment of Creative Achievement

Measures of creative achievement (CAch) ask for the level of attainment one has acquired in one's lifetime in a creative domain. Therefore, CAch reflects a qualitative aspect of creativity in terms of its public impact. A popular measure of CAch is the *Creative Achievement Questionnaire* (CAQ; Carson et al., 2005). The CAQ comprises 96 achievements organized by 10 creative domains. For example, in the domain *Inventions*, levels range from "I have no recognized talent in this area" to "I have sold one of my inventions to a manufacturing firm." The CAQ shows high internal consistency ($\alpha > .90$) and correlates with expert ratings of artistic products and the personality factor of openness (Carson et al., 2005).

The Lifetime Creativity Scale (LCS) by Richards, Kinney, Benet, and Merzel (1988) consists of an informal interview that requires naming creative activities (*extent of involvement in creative activity*) and achievements (*peak creativity*), which are assessed in both the vocational domain (activity one is paid for) and the avocational domain (activity one is not paid for). Self-reported creative accomplishments are then evaluated by judges on a 6-point scale ranging from *not significant* to *exceptional*. The LCS scores show high reliability in terms of interrater agreement (.88 for the overall measures) as well as concurrent validity (e.g., correlations with appreciation of creativity were around .3; Richards et al., 1988).

Which Are Common Creative Domains?

The most prominent distinction of domains refers to *artistic* versus *scientific* creativity (Feist, 1998). When aiming for more fine-grained domains, different researchers have used different sets of domains: The CBI includes items from the domains of literature, music, crafts, art, math and science, performing arts, and a miscellaneous category; the BICB encompasses items from literature, crafts, architecture, visual arts, cooking, performing arts, science, as well as social creativity domains. Both the CBI and the BICB feature a variable number of activities per domain, and they are not designated to compute domain scores. The CAQ domains include visual arts, music, dance, architectural design, creative writing, humor, inventions, scientific discovery, theater and film, and culinary arts. Finally, the K-DOCS activities were shown to group into five domains: self/everyday, scholarly, performance (encompassing writing and music), mechanical/scientific, and artistic (Kaufman, 2012). While some creative domains such as literature and music are present in most inventories, others are used rarely (e.g., architectural design).

A latent-class analysis of the CAQ revealed three classes of creative achievement: the largest group of participants (65.7%) showed no higher achievements in any domain, the second largest group (17.4%) had high achievements only in visual arts, and the smallest group had some achievements in music, dance, creative writing, and theater and film (Silvia, Kaufman, & Pretz, 2009). Similarly, a latent-class analysis of creative activities in the BICB identified three classes,

which mainly differed in the level of creative achievement (von Stumm, Chung, & Furnham, 2011). These results suggest quantitative rather than domain-specific differentiations between people, at least in Little-C samples.

The Rationale of the ICAA

A comprehensive assessment of real-life creativity requires a balanced coverage of accomplishments across creative domains and levels of achievement. However, it is obviously unfeasible to compile an exhaustive list of creative accomplishments and, if it existed, to use it in empirical research. Available inventories thus, aim for representative selections of creative accomplishments, which are necessarily eclectic and selective. This comes with the risk of misjudging a person as more or less creative just because his or her field of engagement happens to be underrepresented or overrepresented in an inventory. While this problem cannot easily be resolved, it seems important to consider a broad range of domains and to represent each domain in a balanced way. Therefore, the ICAA considers eight established domains of creativity, and for each domain it covers six activities and 11 levels of achievement. We selected those domains that have been frequently considered in other self-assessment inventories (Silvia et al., 2012). We also included the less common domain of sports because it proved to be relevant in the CSDD (Kaufman & Baer, 2004) as well as in the pilot study of the ICAA (Zierer, 2011). All reported activities and achievements should refer to the past 10 years, which was deemed large enough to obtain a reliable estimate not missing major events in the recent past, but still limited to a fixed time frame to ensure an equal frame of reference across age.

A differentiated assessment of real-life creativity further requires covering the range from small personal accomplishments to more exceptional ones. Available inventories tend to focus either on Little-C creativity or on Pro-C creativity so that their range of measurement may be restricted. We address this issue in the ICAA in two ways. First, it includes scales for the assessment of both creative activity and achievement. These two scales follow the tradition to measure the quantity of engagement in creative activity (similar to the CBI) and the quality of creative achievement (similar to the CAQ). Both scales consider the same eight creative domains, which enables relating activity and achievement measures across the same domains.

A second way to increase the range of measurement in the ICAA, the achievement scale includes personal *and* public achievements (Runco et al., 2010; Torrance, 1993). Popular achievement measures like the CAQ focus on publically noted achievements like winning prizes and selling work. However, when applied in Little-C samples, which rarely show any of these achievements, these measures may not differentiate well. In the ICAA achievement scale, the first five levels cover personal accomplishments ranging from *I have tried this domain once* to *I have already taken classes to improve my skills*. The final five levels cover publicly acknowledged achievements ranging from *I have already published my original work in this domain* to *I have already sold my work in this domain*. By these means, the ICAA should capture more variance at the lower end of the achievement distribution.

Aims of This Study

The ICAA is designed to assess creative activity and achievement in a balanced and

differentiated way across eight domains. While the ICAA has been previously used in different published studies (e.g., Jauk et al., 2013, 2014; modified versions were also used in Karwowski, 2015; McKay, Karwowski, & Kaufman, 2017), no formal test analysis of the ICAA is available to date. Therefore, we compiled nine available data sets that used the ICAA (seven Little-C samples and two Pro-C samples) to build a large data set for psychometric analyses including item analysis, and analyses of reliability, factorial structure, and different forms of validity. Item analyses include an examination of whether higher achievement levels (receiving higher scores) are actually less frequent (i.e., inspection of ordinality). Validity analyses include comparisons between Little-C and Pro-C samples, and correlations of the ICAA scores with concurrently assessed trait measures including different measures of creativity, personality, and intelligence. Additionally, we examine concurrent validity with the CAQ (Carson et al., 2005). We particularly expect positive associations between creative activity and achievement with openness to experience (Feist, 1998; Kaufman, 2013; Ma, 2009; McCrae, 1987; Puryear, Kettler, & Rinn, 2017), divergent thinking ability (Jauk et al., 2014; Plucker, 1999), and intelligence (Beaty, Nusbaum, & Silvia, 2014; Jauk et al., 2013; Kim, 2008).

Table 1. Overview of Studies and Sample Characteristics

Dataset	Target sample	*N*	Age *M* (*SD*)	% female	% High school diploma	ICAA	Creativity	Personality	Intelligence
1	Students	136	26.23 (9.38)	50.00	61.00	Complete	3 DT tasks (AU)	NEO-FFI	APM
2	Students	165	26.44 (8.56)	54.50	64.20	Only CAct	8 DT tasks (AU)	NEO-FFI	APM; IST
3	Students	99	24.15 (4.98)	67.70	69.70	Complete	3 DT task (AU); RIBS	BFAS	APM; IST
4	Students	200	23.65 (3.77)	49.00	66.50	Complete	2 DT tasks (AU)	—	IST
5	Nonstudent	298	30.46 (10.71)	66.10	59.70	Complete	6 DT tasks (3 AU, 3 IN); CAQ	NEO-PI-R	INSBAT
6	Students	152	23.74 (4.21)	55.90	71.70	Complete	6 DT tasks (3 AU, 3 IN); RIBS	BFAS	ISA
7	Students	243	23.09 (3.65)	68.30	78.20	Complete	4 DT tasks (2 AU, 2 IN); CAQ	NEO-FFI	INSBAT
8	Music students	120	25.09 (5.85)	45.00	100.00	Complete	4 DT tasks (2 AU, 2 IN)	NEO-FFI	—
9	Art students	153	19.99 (4.00)	43.80	100.00	Complete	2 DT (Jokes)	BFI-10	—

Note. All tests are explained in the text. APM = Advanced Progressive Matrices; BFAS = Big-Five Aspect Scales; RIBS= Runco Ideational Behavior Scale; NEO-FFI = NEO-Five Factor Inventory; CAQ = Creative Achievement Questionnaire; BFI = Big Five Personality Inventory; ICAA = Inventory of Creative Activities and Achievements; CAct = creative activity.

Method

Participants

We considered available data from nine independent studies using the ICAA between 2013 and 2014 with a total sample size of $N = 1{,}566$. Part of the data have been previously published (Benedek et al., 2014a, 2014b; Jauk et al., 2013, 2014). The samples include seven Little-C samples and two Pro-C samples (for an overview of characteristics of individual samples, see Table 1). The Little-C samples were pooled (see analysis section) to obtain a larger total sample for basic psychometric analyses. It comprises $n = 1{,}293$ participants in total (59.6% female), with an average age of 26 years ($SD = 7.83$) and high school diploma as the most common highest level of completed education (67.1%). One Pro-C sample consisted of German-speaking students of instrumental pedagogy at the University of Music and Arts in Graz ($n = 120$). They majored in various different musical instruments (e.g., piano, violin, and voice), and were enrolled in one of three tracks related to a specific genre of music: classical music (51%), jazz music (26%), and folk music (18%); 5% were enrolled in more than one genre track. While

still being students, they were already highly accomplished as indicated by the number of their own music productions or concerts played (Benedek et al., 2014a). The other Pro-C sample was an U.S.-sample consisting of n = 153 participants, who had attended a university devoted to training in the arts for at least 2 years on average (SD = 1.01). The participants' college majors were dance (9.2%), drama (17%), drawing and painting (28.8%), filmmaking (34.6%), and music (10.5%).

Measures

The ICAA. The ICAA is a self-report measure that assesses CAct and CAch in separate scales across eight domains (an English and German version is available via the Open Science Framework at https://osf.io/4s9p6/). The English version of the ICAA was double-checked by both an American native speaker and a German living and working in the United States. The domains were selected according to their popularity in other measures of CAct and CAch and include literature, music, arts and crafts, creative cooking, sports, visual arts, performing arts, and science and engineering.

The CAct scale is conceptually similar to the CBI (Hocevar, 1979) and asks how frequently a certain activity has been performed in the past 10 years. This long but fixed time frame of reference (10 years) was chosen to obtain a differentiated assessment while still reducing the presumed bias by age. Answers are given on 5-point Likert-type scale (0 = *never*; 1 = *1–2 times*; 2 = *3–5 times*; 3 = *6–10 times*; 4 = *more than 10 times*). Each CAct domain scale consists of six items. An example activity for the literature domain is "Wrote a short literary work (e.g., poem, short story)." Averaging across the six items yields a domain-specific CAct score; a domain-general score can be computed by further summing across the eight domains.

The CAch scale assesses creative achievement on 11 different levels of attainment per domain. This scale is similar to the CAQ (Carson et al., 2005), but unlike the CAQ, the same levels of attainment are used in each domain. Participants check each level of attainment that applies to them in a certain domain, ranging from *I have never been engaged in this domain* to *I have already sold some work in this domain*. Each level of attainment corresponds to an increasing value from 0 to 10 and multiple answers are possible. Summing across all marked levels of attainment yields a domain-specific CAch score (cf. Carson et al., 2005), which potentially ranges from 0 to 55 (all 10 levels above 0 selected). A domain-general score can be obtained by summing across the eight domains.

Creativity measures. In two samples, we additionally assessed creative achievement using the CAQ (Carson et al., 2005). The CAQ contains one score for self-indicated talent, one achievement score per domain, and one general achievement score. ICAA domains are not exactly congruent with CAQ domains: The CAQ includes the domain of humor, but not the domains sports and arts and crafts. Moreover, visual arts and architecture (CAQ) correspond to visual arts (ICAA), dance and theater & film (CAQ) to performing arts (ICAA), and science and inventions (CAQ) to science and engineering (ICAA).

Creative Potential was assessed by two types of divergent thinking tasks: In the alternate uses (AU) task, participants were asked to find creative uses of objects (e.g., "a brick"), and in the

instances task, participants were asked to find creative instances of given properties (e.g., "What can be round?"). Some data sets used either of these tasks and two data sets used both. All tasks were scored for ideational *fluency* and *originality.* Fluency reflects the total number of responses given. For the *top-3 originality* score, external originality ratings (3–6 raters per study) were averaged across the three most creative responses per task. This top-scoring method has been shown to yield lower confounding with fluency (Benedek, Mühlmann, Jauk, & Neubauer, 2013; Silvia et al., 2008) and hence captures unique, complementary variance of creative potential (Jauk et al., 2014; Kellner & Benedek, 2017). In the data sets containing both tasks these correlated .46 and .40 (both $p < .01$) and were averaged. Ideational behavior was measured via 17 self-report items of the Runco Ideational Behavior Scale (RIBS; Runco, Plucker, & Lim, 2001).

Personality. We assessed the Big Five personality dimensions using the NEO-Five Factor Inventory (NEO-FFI; Borkenau & Ostendorf, 1994), the NEO-PI-R (Ostendorf & Angleitner, 2004), or the Big-Five Aspect Scales (BFAS; DeYoung, Quilty, & Peterson, 2007) in the different samples. The American validation sample used an abbreviated Big Five Personality Inventory (BFI-10; Rammstedt & John, 2007). The BFAS provides the two facets openness and intellect of the Big Five dimension openness to experience.

Intelligence. Intelligence was assessed by five different tests: Advanced Progressive Matrices (APM; Raven, Court, & Raven, 1980), Intelligenz-Struktur-Test, 2000-R (Amthauer, Brocke, Liepmann, & Beauducel, 2007), Intelligenz-Struktur-Analyze (Gittler, 2001), and Intelligenz-Struktur-Batterie (Arendasy et al., 2004). Scores for three dimensions of intelligence—verbal, numerical, and figural intelligence—were used wherever applicable in addition to a common score representing general intelligence. The APM was used as figural intelligence in the BIS model (Jäger, Süß, and Beauducel, 1997).

Analysis Plan

We first present item and scale statistics of the ICAA items based on a pooled data set consisting of seven Little-C samples. We assessed reliability of CAct scales by means of Guttman's λ, which gives different estimates of internal consistency: λ3, which equals Cronbach's α, λ2, which does not assume τ-equivalent measurement and, therefore, accounts for the intercorrelations of activity items, and finally λ4, which is an estimate of Guttman's split-half reliability (Guttman, 1945).

For CAch scales, the 10 response options are assumed to reflect increasing achievement levels. Because these levels are not independent, we did not test for reliability but rather tested the assumed ordinality of the achievement levels via frequency tables for each domain.

We examined the adequacy of the presumed factorial structure with a correlated uniqueness model (see Figure 1). This type of structural equation model allows for more stable estimations than the classical multitrait-multimethod models (Kline, 2011). In this model, latent CAct and CAch factors are defined by their respective domain-scores. Additionally, CACt and CAch scales from the same domains were allowed to correlate (e.g., CAct literature is allowed to

correlated with CAch literature etc.).

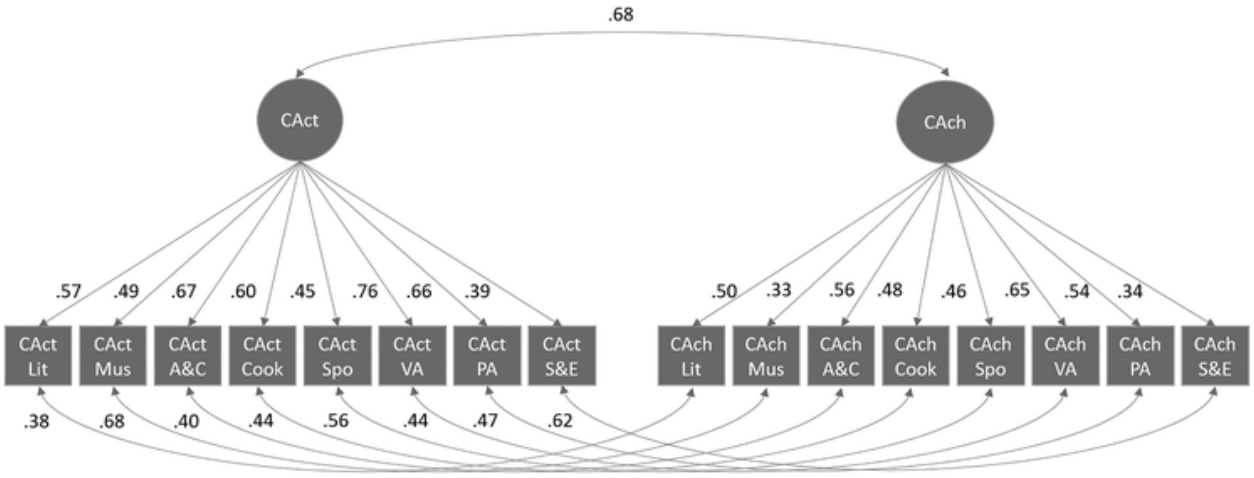

Figure 1. Correlated uniqueness model. All coefficients are $p < .01$. Lit. = Literature; Mus = Music; A&C = Arts & Crafts; Cook. = Creative Cooking; Spo. = Sports; VA = Visual Arts; PA = Performing Arts; S&E = Science & Engineering.

Validity of the ICAA scores was tested by applying meta-analysis techniques to our data sets. Validity information was obtained with respect to trait measures of creative achievement, creative potential, and personality and intelligence. Because the validity measures have been assessed by slightly different tasks and forms across studies—for example, for the measurement of creative potential between two and eight tasks, rated by three to six raters have been used—simple pooling of these data would have yielded distorted results. Therefore, we borrowed the technique of meta-analysis as a sophisticated way to determine the variables relationships on the construct level. Following the recommendations by Lipsey and Wilson (2001), correlations between ICAA scores and validity variables were transformed to Fisher's-*z* effect sizes and weighted by the inverse of its variance for each data set individually. Next, these effect sizes were averaged and tested for homogeneity. Finally, effect sizes were transformed back into correlations coefficients to facilitate interpretation. This procedure allows for significance testing of meta-analytic correlations. Because a large number of meta-analytic correlations was calculated, the interpretation will focus on emerging patterns of effect sizes rather than statistical significances of individual correlations (Cumming, 2014).

As another test of validity, we compared ICAA scores from two Pro-C samples with the pool data set. The specificity of the ICAA would be supported if, for example, the musicians sample showed increased scores in the domain of music but not in other domains.

Results

Item Analysis

Table 2 presents item difficulty and discriminatory power of the 48 items of the ICAA CAct scale. Item difficulties ranged from .07 to .80 and items can generally be considered as rather difficult ($M = 0.24$, $SD = 0.15$). Figure 2 presents the relative frequency of the 10 CAch levels per domain. Overall, the pattern suggests largely monotonically decreasing frequencies for

higher levels of achievement. The majority of people have had first experience with each creative domain (60–70% at level 1) but only 20% have presented their original work to strangers (level 4); 10–20% have taken classes to improve skills (level 5) in most domains, except for the domains of sports and music, where we observed a slight increase in frequency. Creative achievement at higher level (6 to 10) usually shows frequencies less than 10% across all domains.

Table 2. Items Statistics of the ICAA Creative Activity Scales

Variable	Item	Median	p	r_{it}
Literature	1	1	.39	.43
	2	0	.07	.24
	3	0	.15	.38
	4	0	.15	.44
	5	0	.17	.30
	6	0	.24	.35
Music	1	0	.12	.57
	2	0	.19	.67
	3	1	.28	.77
	4	1	.29	.76
	5	0	.18	.62
	6	1	.38	.39
Creative cooking	1	2	.59	.72
	2	2	.54	.76
	3	2	.49	.54
	4	0	.09	.39
	5	1	.35	.66
	6	1	.24	.49
Arts and crafts	1	2	.47	.70
	2	2	.50	.80
	3	2	.60	.76
	4	2	.47	.75
	5	0	.11	.30
	6	0	.17	.50
Sports	1	0	.12	.58
	2	0	.10	.57
	3	0	.12	.65
	4	0	.05	.38
	5	0	.16	.60
	6	1	.29	.48
Visual arts	1	2	.47	.57
	2	1	.25	.61
	3	0	.09	.42
	4	1	.40	.64
	5	0	.12	.54
	6	1	.25	.56
Performing arts	1	0	.16	.44
	2	0	.10	.40
	3	0	.15	.56
	4	0	.13	.53
	5	0	.22	.44
	6	0	.07	.29
Science and engineering	1	1	.24	.39
	2	0	.14	.53
	3	0	.22	.63
	4	0	.16	.67
	5	0	.13	.56
	6	0	.12	.44

Note. ICAA = Inventory of Creative Activities and Achievements; p = item difficulty; r_{it} = item-total-correlation.

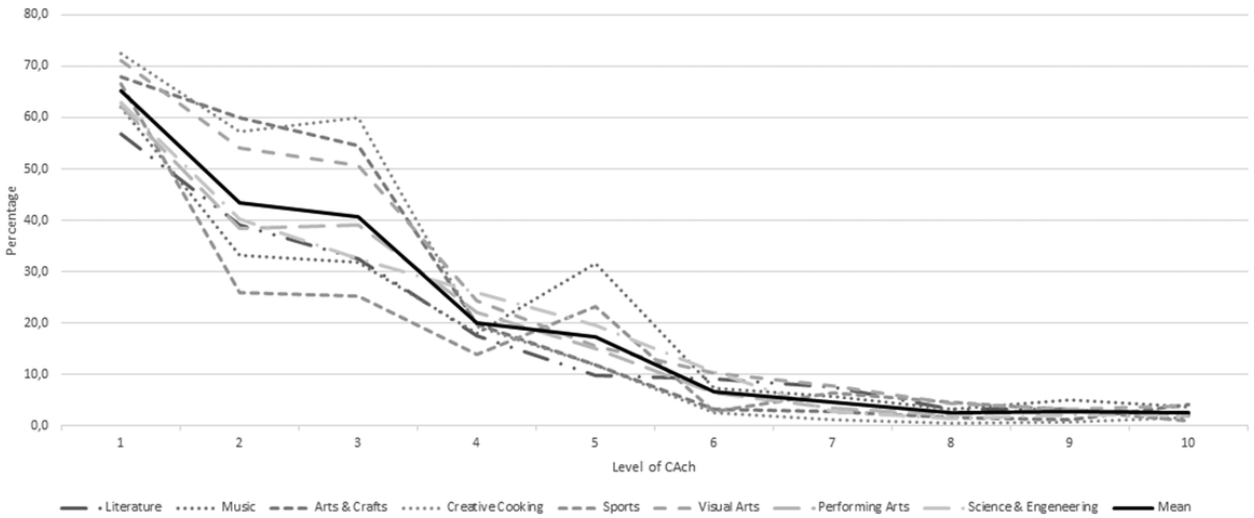

Figure 2. Frequency of creative achievements. Levels of Creative achievement: 1 = "I have tried this domain once."; 2 = "I have already created at least one original work in this domain"; 3 = "I have presented my original work in this domain to some friends"; 4 = "I have presented my original work in this domain to strangers"; 5 = "I have already taken classes to improve my skills in this domain"; 6 = "I have already published my original work in this domain"; 7 = "I have already participated in a contest in this domain"; 8 = "I have already won an award or prize for my original work in this domain"; 9 = "Media have already reported about my work in this domain"; 10 = "I have already sold some of my work in this domain."

Table 3. Scale Statistics for Little-C Pooled Sample and Comparison With Pro-C Samples

ICAA domain	Little-C pool						Music students			Arts students		
	M	*SD*	Skew/Kurt	λ_2	λ_3	λ_4	*M*	*SD*	Cohens *d*	*M*	*SD*	Cohens *d*
CAct												
Lit.	5.59	3.98	.69**/.17	.63	.62	.59	6.07	3.87	.04	17.05	4.40	.88
Mus.	6.81	6.19	.98**/.22	.85	.84	.84	16.05	5.95	.73	18.54	6.80	.84
A&C	10.82	5.67	.04/−.83**	.87	.85	.80	11.41	5.60	.05	20.85	5.78	.73
Cook.	10.64	5.71	.07/−.81**	.84	.82	.75	11.48	6.33	.07	16.88	6.61	.45
Spo.	4.05	4.57	1.49**/2.06**	.79	.78	.72	5.09	4.97	.09	11.30	5.69	.55
VA	7.51	5.05	.67**/−.09	.81	.80	.83	7.46	5.27	.00	16.75	5.34	.69
PA	4.15	3.87	1.08**/1.01**	.73	.71	.72	4.26	3.80	.01	15.09	4.98	.84
S&E	4.96	4.97	1.27**/1.14**	.79	.78	.76	4.08	4.43	−.07	12.65	4.94	.58
Sum	54.51	25.65	.47**/−.11	.80	.79	.79	65.67	25.29	.39	129.10	26.61	2.50
CAch												
Lit.	6.14	8.85	2.24**/5.42**				5.87	6.80	−.02	16.68	10.29	.68
Mus.	6.01	9.04	2.83**/9.52**				20.08	15.91	.94	13.40	12.93	.47
A&C	6.59	6.87	2.55**/9.52**				9.21	11.93	.20	15.94	13.92	.63
Cook.	6.26	5.66	2.52**/12.04**				7.76	12.51	.12	7.31	7.15	.08
Spo.	5.72	9.21	2.89**/9.52**				5.68	7.15	.00	9.32	10.72	.23
VA	8.34	10.31	2.07**/4.41**				7.49	8.43	−.06	16.63	12.88	.50
PA	6.20	9.11	3.23**/18.26**				7.29	9.09	.08	25.20	15.57	1.17
S&E	6.67	8.84	1.96**/4.60**				6.17	8.45	−.04	9.37	8.15	.18
Sum	51.83	39.22	1.33**/2.24**	.71	.71	.71	69.23	42.15	.41	113.85	49.79	1.39

Note. Skew = Skewness; Kurt = Kurtosis; λ_2 –λ_4 = Guttman's lambda; Lit. = Literature; Mus. = Music; A&C = Arts & Crafts; Cook. = Creative Cooking; Spo. = Sports; VA = Visual Arts; PA = Performing Arts; S&E = Science & Engineering; Sum = Sum score across all domains.
** $p < .01$.

Scale Analysis

Domain-level CAct scores displayed a positively skewed distribution (see Table 3), indicating that most activities have been performed infrequently in the last 10 years. Furthermore, the distributions were predominantly pointy according to their kurtosis. Creative activity is most frequently performed in the domains arts-and-crafts and creative cooking and least frequently in the domains of sports and performing arts. The six items of each domain generally show satisfactory internal consistency ($\lambda 3 > .70$), except for the domain of literature where internal consistency was only moderate ($\lambda 3 = .62$; see Table 3).

Regarding CAch scales, people showed on average low levels of achievement in all eight domains, and CAch scores displayed positive skewness and predominantly pointy distributions (see Table 3). These distribution characteristics indicate that only few people showed high creative achievement in any domain.

The CAct domain scales were substantially correlated with the corresponding CAch domain scales, with correlations ranging from $r = .45$ (literature) to $r = .67$ (music). More important, all correlations of CAct and CAch were highest for the same domain compared with other domains—for example, CAct (music) correlated highest with CAch (music) compared with other CAch domains (see Table 4).

Table 4. Correlations of Creative Activity (CAct) and Creative Achievement (CAch) Scales across Domains

	CAch domain								
CAct domain	Lit.	Mus.	A&C	Cook	Spo.	VA	PA	S&E	CAch sum
Lit.	.45	.21	.14	.21	.18	.22	.29	.18	.42
Mus.	.17	.67	.14	.21	.21	.20	.24	.25	.46
A&C	.16	.07	.50	.28	.17	.31	.22	−.02	.34
Cook	.16	.12	.24	.51	.15	.20	.17	.09	.33
Spo	.05	.12	.14	.20	.57	.13	.15	.15	.33
VA	.22	.17	.40	.27	.18	.56	.31	.22	.51
PA	.27	.22	.25	.24	.29	.31	.56	.12	.50
S&E	.13	.17	.09	.11	.16	.21	.10	.62	.36
CActsum	.30	.36	.37	.41	.36	.41	.38	.31	.62

Note. All correlations are significant in the given sample size of $n = 1293$; Lit. = Literature; Mus. = Music; A&C = Arts & Crafts; Cook = Creative Cooking; Spo. = Sports; VA = Visual Arts; PA = Performing Arts; S&E = Science & Engineering; Sum = Sum score across all domains.

Factorial Analysis

Because of the skewed distributions of CAct and CAch the Satorra-Bentler correction (Satorra & Bentler, 1988) was applied to the model estimation. Figure 1 shows the analyzed correlated uniqueness model. The fit-indices of the model ($\chi^2[95] = 458$, $p < .01$; comparative fit index [CFI] = 0.92; root mean square error of approximation [RMSEA] = 0.07; standardized root mean square residual [SRMR] = 0.05) generally meet the criteria established by Hu and Bentler (1999), suggesting that the postulated model fits to the data reasonably well. All domains show good factor loadings ($\lambda = .45$ to .76) on their respective latent variable (CAct vs. CAch), only music loads lower on CAch ($\lambda = .33$) and science and engineering loads lower on both CAct and

CAch (λ = .39 and .34, respectively). The correlated uniqueness of the domains (r = .38 to .68) indicates a substantial amount of domain-specific variance across CAct and CAch. The latent correlation between CAct and CAch was r = .68.

Validity Analysis

Sociodemographic variables. Age showed small negative correlations with most ICAA activity and achievement domains (Table 5; additional data are provided as online supplemental material). Point-biserial correlations with gender were small to high and showed that women are more frequently engaged in creative activities in the arts and crafts domain, whereas men are more frequently engaged in the science and engineering domain. Regarding CAch, women showed higher creative achievements in music, whereas men showed higher creative achievements in the performing arts.

Table 5. Meta-Analytical Correlations of the ICAA With Sociodemographic Variables and the CAQ

			CAQ											
ICAA domain	Age	Gender	CAct sum	Creative writing	Music	Culinary arts	Visual arts	Architecture	Dance	Theatre & film	Scientific discovery	Inventions	Humor	CAch sum
CAct														
Lit.	−.15**	.15**	.30**	.42**	.20**	.13**	.12**	−.09*	.10*	.32**	.13**	.13**	.37**	.32**
Mus.	−.14**	.41**	.34**	.23**	.57**	.08	.14**	−.07	.12**	.23**	.13**	.13**	.24**	.40**
A&C	−.06*	−.56**	.27**	.19**	.15**	.13**	.32**	.06	.18**	.09*	.04	.16**	.06	.27**
Cook.	.01	−.30**	.26**	.21**	.19**	.44**	.19**	−.03	.04	.16**	.04	.12**	.09*	.21**
Spo.	−.02	.36**	.33**	.20**	.14**	.05	.11*	−.07	.21**	.09*	.03	.10*	.15**	.23**
VA	−.11**	−.12**	.33**	.19**	.17**	.14**	.44**	.26**	.14**	.12**	.06	.28**	.09*	.33**
PA	−.16**	−.30**	.39**	.29**	.30**	.04	.27**	−.06	.37**	.33**	.02	.10*	.20**	.42**
S&E	.04	.61**	.27**	.16**	.14**	.04	.07	−.01	.02	.07	.23**	.39**	.22**	.24**
Sum	−.11**	−.12**	.48**	.36**	.37**	.22**	.32**	.01	.21**	.27**	.13**	.26**	.27**	.46**
CAch														
Lit.	−.10**	.25**	.21**	.63**	.28**	.11*	.19**	−.03	.1*	.24**	.06	.02	.24**	.36**
Mus.	−.13**	−.31**	.27**	.35**	.74**	.11*	.19**	−.07	.19**	.20**	.02	.02	.15**	.43**
A&C	−.08**	−.09**	.21**	.15**	.15**	.08	.38**	.04	.18**	.12**	.06	.14**	.10*	.30**
Cook.	−.02	.19**	.24**	.24**	.16**	.57**	.10*	−.02	.03	.09*	.09*	.07	.11**	.20**
Spo.	−.06*	−.10**	.29**	.20**	.20**	.02	.09*	−.05	.35**	.11*	.02	.07	.12**	.34**
VA	−.08**	−.11**	.26**	.23**	.17**	.17**	.55**	.21**	.14**	.20**	.04	.19**	.16**	.38**
PA	−.10**	.52**	.28**	.29**	.24**	.00	.21**	−.02	.43**	.47**	.01	.06	.23**	.45**
S&E	.08**	.07*	.23**	.18**	.13**	.04	.04	−.01	.04	.10*	.49**	.31**	.21**	.32**
Sum	−.11**	.09**	.42**	.50**	.45**	.20**	.39**	.02	.32**	.34**	.16**	.18**	.30**	.61**

Note. Lit. = Literature; Mus = Music; A&C = Arts & Crafts; Cook. = Creative Cooking; Spo. = Sports; VA = Visual Arts; PA = Performing Arts; S&E = Science & Engineering; Sum = Sum score across all domains; ICAA = Inventory of Creative Activities and Achievements; CAct = creative activity; CAch = creative achievement. Gender was coded 1 = female, 2 male.
* $p < .05$. ** $p < .01$.

Concurrent validity with the CAQ. ICAA CAch scales were highly correlated with CAQ scales (see Table 5), particularly in achievement domains that are conceptually overlapping (e.g., ICAA music with CAQ music r = .74). In cases in which one CAQ domain is represented by two ICAA domains, correlations were slightly smaller for each domain individually. Hence, correlations with the CAQ provide clear evidence for concurrent validity of the ICAA scores.

Creative potential. CAct was significantly correlated with both divergent thinking fluency and originality (see Table 6). Fluency yielded small correlations with CAch around r = .15. CAch correlations with originality were generally smaller than for CAct and did not reach statistical significance for all domains (see Table 6). ICAA scales showed consistent positive associations

with self-reported ideational behavior (RIBS) across all domains.

Table 6. Meta-Analytical Correlations of the ICAA with Divergent Thinking Ability, Personality, and Intelligence

ICAA domain	RIBS	DT fluency	DT originality	Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness	BFAS - intellect	BFAS - openness	Figural intelligence	Numerical intelligence	Verbal intelligence	Intelligence
CAct														
Lit.	.32**	.24**	.28**	.02	.15**	.30**	−.13**	−.07	.19**	.19**	.11**	.05	.10**	.10**
Mus.	.26**	.14**	.23**	−.02	.06	.24**	−.07*	−.08*	.06	.25**	.16**	.08**	.08*	.13**
A&C	.15*	.16**	.09*	.01	.21**	.26**	.12**	.11**	.12	.19**	.06*	−.09**	−.04	−.03
Cook.	.23**	.19**	.16**	.00	.22**	.29**	.09**	.05	.16*	.15*	.06	−.02	.06	.03
Spo.	.26**	.09**	.05	−.05	.14**	.13**	−.05	.06	.23**	.05	.03	−.02	.02	.02
VA	.28**	.19**	.16**	.02	.09*	.29**	.03	.03	.13*	.24**	.16**	−.02	.08*	.08**
PA	.21**	.21**	.19**	.05	.24**	.27**	.01	−.01	.09	.24**	.03	.00	.03	.02
S&E	.24**	.16**	.20**	−.03	.01	.15**	−.12**	.06	.16*	−.19**	.20**	.15**	.12**	.19**
Sum	.41**	.27**	.26**	.00	.22**	.38**	−.02	.03	.23**	.23**	.17**	.02	.09**	.11**
CAch														
Lit.	.28**	.17**	.18**	−.03	.07	.26**	−.10*	−.05	.20**	.25**	.11**	.06	.10**	.14**
Mus.	.20**	.12**	.22**	−.02	.06	.18**	.01	−.05	.04	.16*	.12**	.09**	.05	.13**
A&C	.18**	.10**	.07	.03	.04	.14**	.05	.04	.01	.21**	.10**	−.04	.00	.02
Cook.	.14*	.10**	.13**	.04	.18**	.21**	.07	.05	.03	.13*	.05	−.01	.00	.02
Spo.	.13*	.11**	.16**	.03	.05	.16**	.00	.07	.18**	.16*	.06	.05	.07*	.10**
VA	.28**	.09**	.16**	.02	.01	.23**	−.02	−.03	.11	.30**	.13**	−.01	.05	.06
PA	.11	.15**	.20**	.03	.14**	.18**	.04	−.03	.04	.18**	.09**	.07*	.08*	.11**
S&E	.18**	.14**	.18**	.01	−.03	.10**	−.17**	.05	.13*	−.12	.17**	.15**	.11**	.18**
Sum	.37**	.22**	.29**	.01	.10*	.32**	−.04	.00	.19**	.30**	.19**	.09**	.11**	.18**

Note. Lit. = Literature; Mus = Music; A&C = Arts & Crafts; Cook. = Creative Cooking; Spo. = Sports; VA = Visual Arts; PA = Performing Arts; S&E = Science & Engineering; Sum = Sum score across all domains; DT = Divergent thinking; BFAS = Big Five Aspect Scales; ICAA = Inventory of Creative Activities and Achievements; CAct = creative activity; CAch = creative achievement.
* $p < .05$. ** $p < .01$.

Personality. CAct and CAch correlated consistently and positively with Openness (mostly .20 < *r* < .30); correlations were slightly more pronounced for CAct especially at the facet level (see Table 6; additional data are provided as online supplemental material). Positive correlations were also observed with extraversion, particularly with CAct, but less consistently with CAch domain scores. In contrast, some ICAA scales correlated negatively with agreeableness. Correlations with conscientiousness and neuroticism were largely very small and nonsignificant.

Intelligence. Intelligence measures showed only minor correlations with measures of CAct, both for general intelligence and for the constituting domains of verbal, figural, and numerical intelligence (see Table 6). The correlation pattern between CAch and intelligence was very similar as for CAct, with correlations being slightly higher on average.

Validation With Pro-C Samples

We first compared the Little-C pool with the Pro-C sample of musicians (see Table 3). Musicians showed both higher levels of creative activity (Cohen's $d = 0.73$) and achievement in music ($d = 0.94$), but not in any other domain (all *d*s < 0.10 for CAct and <.20 for CAch).

We then compared the Little-C pool with the Pro-C sample of art students. Art students showed higher levels of CAct in all domains (all *d*s > 0.40). Regarding CAch, art students excelled the Little-C pool data set in the performing arts, literature, visual arts, music, and arts and crafts (*d*s > .45), but they did not show substantially higher achievements in domains outside their fields of study such as science and engineering, sports, or cooking (*d*s < .25).

Discussion

The prediction of real-life creativity requires a reliable and valid measure of the criterion (Shapiro, 1970). Available measures tend to focus either on creative activity (CAct) or creative achievement (CAch) and share some problems, such as an unbalanced representation of creativity domains or restricted differentiation in the lower part of the achievement distribution. The ICAA aimed to overcome these issues by assessing both CAct and CAch in the same domains, measuring each CAct domain with an equal number of items, and extending the CAch scale to include lower levels of (personal) achievement.

Main Findings

The ICAA scales show acceptable internal consistency for most domains (except for literature). Its factorial structure confirms the assumption that CAct and CAch are related but discriminable traits. Meta-analytic correlations with other measures provided evidence for convergent and discriminant validity of the ICAA scores. The ICAA showed the highest correlations with the CAQ, another well-established measure of creative achievement. Evidence for concurrent validity was obtained for the total CAQ score, but also at the level of single domains: conceptually similar domains showed higher correlations than unrelated domains.

We observed consistent positive correlations of ICAA scales with openness to experience and self-reported ideational behavior, and, to a lesser degree, with creative potential and intelligence. These findings are well in line with previous research suggesting that openness to experience, creative potential, and intelligence are important predictors for real-life creativity across most creative domains (Jauk et al., 2014; Kim, 2008). Openness to experience is arguably the most consistent predictor of real-life creativity in creativity research (Feist, 1998; Kaufman, 2013; Nusbaum & Silvia, 2011). Open people try out and engage in diverse new activities and, thus, likely enter creative fields as well. Moreover, the exposure to variegated experiences may be fertile for taking different perspectives on things. For example, higher multicultural experiences (Leung et al., 2008), or being exposed to diversifying experiences (Ritter et al., 2012) have been related to higher creativity.

Generally, the meta-analytical criterion correlations tended to be higher for CAct than for CAch. This may have technical reasons such as that the CAch scores showed higher skewness than the CAct scores. As another explanation, creative achievement typically requires a more complex interplay of several traits that is not fully captured by individual linear relationships (Jauk, Benedek, & Neubauer, 2014). Many traits are assumed to represent necessary but not sufficient conditions of creative achievement (Karwowski et al., 2016). For example, being open to make new inventions may not suffice when relevant abilities or expertise are lacking. Creative achievement is rather thought to be multifactorially determined by individual factors like cognitive ability, personality, motivation, expertise, and social environment factors (Eysenck, 1995; Simonton, 2014).

The findings also show that personality measures predict real-life creativity to a higher degree than indicators of cognitive creative potential (i.e., divergent thinking ability). This result pattern has been previously observed (e.g., Batey, Furnham, & Safiullina, 2010; Jauk et al., 2014) and

may have conceptual but also methodological reasons. A methodological reason could be that personality and real-life creativity were assessed with self-report measures, whereas cognitive potential indicators are measured by performance tests. Higher relationships within self-report measures could be partly because of common method variance, which reflects of the effect of shared biases such as consistency motifs or social desirability (Podsakoff et al., 2003).

Assessing Creative Activity With the ICAA

The CAct scales measured the frequency of engagement in specific creative activity within the last 10 years. In all domain scales, we observed rather low mean frequency values and positively skewed distributions. The positive skewness indicates that people commonly indicated that they had never or hardly ever engaged in the presented creative activity. The distributions of CAch and (to a lesser degree) CAct are well known to be positively skewed (Silvia et al., 2012). If we still wanted to improve the scale distribution in future test revisions, we might either consider a longer time period than 10 years, select more common activities, or restrict the range of frequency options. Considering the last 10 years seemed like a reasonable time frame: It is substantially longer than the BICB, which only considers the last year, but still more restricted than the CBI, which considers the entire adolescent or adult life. It should be noted that using an unrestricted time period also implies that younger people necessarily refer to shorter time periods.

The CAct domain scores ranged from 4 (sports, and performing arts) to 11 (arts and crafts, and creative cooking). The ICAA attempted to ensure a balanced representation of activities across domains by using equal amounts of items, but it is still hard to tell whether the used activities reflect a representative selection. Producing a sculpture may simply be more time-consuming than embellishing an everyday object. As another explanation, variation across domains may reflect given differences in popularity and also in the formal accessibility to specific creative domains (e.g., engaging in handicraft may be more common than engaging in the performing arts). Future research may take a bottom-up approach by asking people to openly generate all activities they engage in and examine whether this reveals equal preferences across domains.

Assessing Creative Achievement With the ICAA

The ICAA adopted the intuitive scoring scheme that a higher level of achievement is assigned more points (cf. CAQ; Carson et al., 2005). However, so far, this assumed hierarchy of achievement levels has not been empirically tested—neither for the ICAA nor the CAQ. Therefore, we examined whether higher levels of creative achievement in the ICAA are actually characterized by higher infrequency. The presumed ordinality of the 10 achievement levels (excluding the first level: “no achievement”) in the ICAA was found to be generally supported by the data. For most domains, increasing levels of creative achievement are associated with monotonically decreasing frequencies in the Little-C sample. As a notable exception, level 5 (“I have already taken classes to improve my skill in this domain”) was selected more frequently than level 4 (“I have presented my original work to strangers”) in the domain of music and the domain of sports, whereas it followed the expected trend in the other six domains. Indeed, formal training can easily happen more frequently than openly presenting one’s original work. More importantly, however, level 5 is conceptually different from the other levels, because formal

training is a sign of engagement but not an actual level of achievement. Therefore, although this level is also used in some domains of the CAQ, we suggest that it can be excluded in future assessments.

Further minor violations to ordinality were observed between level 2 ("I have created at least one original work in this domain") and level 3 ("I have presented my original work to some friends"). This is unclear because level 2 is a necessary precondition of level 3. Finally, levels 6 to 10 were reported only very infrequently (usually <10%) in the Little-C sample, which impedes a reliable examination of differences. A more robust examination of the ranking of creative achievement would require Pro-C samples for each domain. In our study, the musicians sample was the only larger homogenous Pro-C sample. The frequencies of CAch in music were about five times higher in the musicians compared with the students sample, especially on the highest five levels (e.g., level 10: 3.8% in students sample compared with 23.3% in musicians sample).

Which Measure to Use?

The comparison of ICAA scores between the Little-C pool and Pro-C samples showed that CAct and CAch scales are both sensitive to differences between Little-C and Pro-C creativity. The musicians sample showed significantly higher creative activity and creative achievement in the domain of music but not in the other seven domains, which corroborates the specificity of the ICAA domain scales. A previous analysis of the musicians data also revealed that jazz musicians show even higher creative achievement than classical or folk musicians, pointing to the discriminatory power of the ICAA even within domains (Benedek et al., 2014a). The art student sample showed higher creative activity and achievement than the Little-C sample in most domains, which may be explained by the broad representation of majors in this sample.

While CAct and CAch scales may generally discriminate well between Little-C and Pro-C samples, their discriminatory power seemed to differ when looking at within-group differences. For the Little-C group, we observed substantial floor effects in the highest (public) achievement levels of the CAch scale but not in the lower levels that reflect personal achievement. This finding is well in line with the well-established notion that most people engage in everyday creative activity, but only very few attain publically noted creative achievement (Eysenck, 1995; Richards et al., 1988; Simonton, 1999). In contrast, the Pro-C sample was at the verge of a ceiling effect in the CAct scales, but showed markedly higher means and variance in the CAch scales. Obviously, musicians have performed most of the creative musical activities (e.g., "invented a melody") more than 10 times in the last 10 years—some of them likely even did so in the last month.

These findings indicate that the CAct and CAch scales may be differently suited to discriminate between and within Little-C and Pro-C populations. If one wants to assess the amount of creative engagement in Little-C populations, which usually do not have many notable public achievements, then using CAct scales may be most appropriate. If a more heterogeneous sample is investigated or differences between Little-C and Pro-C samples are examined (as in an expert-novice design), then CAct and CAch scales may both be useful. Finally, to assess creativity differences within Pro-C samples, the CAch scale will provide more discriminatory power than the CAct scale.

Limitations and Future Directions

We examined a total of nine independent data sets that were available for the ICAA. However, eight samples come from an Austrian lab using the German version of the ICAA, and only one study came from an U.S. lab using the English version of the ICAA. ICAA CAct items have also been translated to Polish and used in adopted versions in Karwowski (2015) and McKay et al. (2017), where they proved to be of high reliability (overall $\alpha = .92$; and for single domains, α between .71 and .92). We hope to have access to more diverse samples coming from different labs in the future. Specifically, a psychometric comparison of the German and English version was not possible as the only English sample represented a specific Pro-C sample. Moreover, as previously noted, a more robust test of the ordinality of achievement levels would require Pro-C samples for each domain, which are not yet available.

The ICAA provides a broad assessment across many relevant creative domains and achievement levels. Some of these domains are well-established (e.g., literature or music), others are still up for debate (e.g., sports, or creative cooking), and yet others might be missing and included in future revisions (e.g., interpersonal creativity). Such a broad assessment takes time, and time can be costly, particularly when investigating Pro-C samples that are hard to recruit. Because Pro-C samples show the most relevant achievement in one specific domain (Kaufman & Beghetto, 2009) a more targeted assessment (e.g., using just relevant domain scales) may appear advisable in Pro-C samples. This saves time and avoids unnecessary nuisance for participants (e.g., when highly accomplished musicians answer questions about their creative achievements in science and engineering). An alternative approach for an efficient assessment of Pro-C creativity is to use the "Top 5 achievement scale," which has been recently added to the ICAA. Similar to the notion of peak achievement in the LCS (Richards et al., 1988), participants are asked to briefly describe the five most creative achievements in their lives. An important advantage of this scale is that it can be readily used with every target sample, no matter what domain or level of achievement. This avoids any risk of failing to cover niches of creative domains. The obvious downside of using an open response format is that responses have to be evaluated by judges, which again should be experts in this domain (Kaufman et al., 2013).

Conclusion

In this article, we provide a psychometric investigation of the ICAA, a broad-based and versatile inventory for assessment of real-life creativity across various domains and levels of achievement. The findings provide first evidence for the reliability and validity of the ICAA scales scores in the assessment of creative activity and achievements, but also reveal directions for future improvements. Additionally, the findings shed light on the prevalence for specific creative activities and creative achievements in Little-C and Pro-C samples. Specifically, a quantity-based assessment of creative activity appears more appropriate for real-life creativity in Little-C populations, whereas a quality-based assessment of creative public achievement appears more appropriate for Pro-C samples. We propose using the ICAA as a modular inventory by adapting the selection of scales to the specific goals of an investigation of real-life creativity.

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