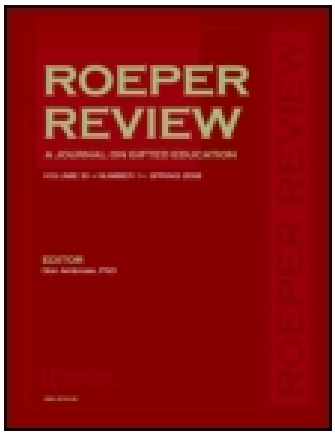

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ASK THE EXPERT:
INSIGHTS ABOUT DOMAIN-SPECIFIC EXPERTISE

The Importance of Domain-Specific Expertise in Creativity

John Baer

Although creativity and expertise are related, they are nonetheless very different things. Expertise does not usually require creativity, but creativity generally does require a certain level of expertise. There are similarities in the relationships of both expertise and creativity to domains, however. Research has shown that just as expertise in one domain does not predict expertise in other, unrelated domains, creativity in one domain does not predict creativity in other, unrelated domains. People may be expert, and people may be creative, in many domains, or they may be expert, or creative, in few domains or none at all, and one cannot simply transfer expertise, or creativity, from one domain to another, unrelated domain. The domain specificity of creativity matters crucially for creativity training, creativity assessment, creativity research, and creativity theory. The domain specificity of creativity also means that interdisciplinary thinking, interdisciplinary collaboration, and interdisciplinary creativity are even more important than one would assume if creativity were domain general.

Keywords: creativity, creativity assessment, domain specificity, expertise, interdisciplinary thinking

"Are you an expert?"

It's impossible to answer this simple question without context: "An expert in what?" Some people may have many areas of expertise, but no one is simply an expert. We are experts in domains, and no one assumes that an expert in cosmetology will also have expertise in cosmology (or vice versa). Expertise in French wines does not overlap with expertise in stock car racing, fencing, Jovian moons, paleontology, or—well, you get the point. Expertise is very domain specific.

Creativity often requires some level of expertise, but expertise and creativity are nonetheless very different things. Someone can know a great deal about something and yet show little creativity in that domain. How much creativity and expertise overlap depends on the domain (i.e., in some domains one might need quite a bit of expertise to do anything that others would deem creative, whereas in other domains much less expertise may be required). But creativity and expertise do share one important attribute: they are both very domain specific.

Think about your own creativity. It certainly varies from domain to domain. There are probably some domains in which you are very creative and many others in which you evidence very little creativity. You may be very creative in your woodworking but a strict recipe-follower when cooking. You may be very creative when designing experiments but would have little flair for designing clothing. Or you might think yourself very creative when writing poetry but are confident that as a comedian you could do no better than recycle a few jokes you have heard.

Despite knowing, if asked, that our own creativity and that of others varies widely by domain, it is easy to forget just how domain specific creativity is. In contrast, it is hard to forget that expertise is domain specific. Why might that be?

Perhaps it is because it is easy to think of creativity—if one doesn't think very hard—as a kind of special spice or sauce or skill that one might add to anything one does, an

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extra something (a particular thinking skill, or a certain kind of motivation, or perhaps just a whimsical open-mindedness) that will make whatever one does more creative. Many people think of intelligence in somewhat that way.[1] But just as adding the same spice or sauce to every recipe will not make everything taste better, there is no skill or set of skills, no generic approach to problems or puzzles, no all-purpose motivational set that will make whatever one is doing more creative. Creativity may seem like something some people just have a lot of (and others very little) because some people are indeed creative in many areas, but that's rather like a cook who has an extensive spice rack and knows how to use it. It isn't that she uses the same spice in every dish. Her expertise, and her creativity, are linked to having many different spices at her disposal and figuring out which spices will work best in which dishes. (And if she is also a creative poet, a creative dancer, and a creative mathematician, her creativity in those domains relies on entirely different sets of skills, ways of approaching problems, and knowledge.)

Even such things as intrinsic motivation, which some research suggests is conducive to creativity, is not something one can transfer from one domain to another. One cannot simply apply one's interest in one kind of activity to other fields one finds less interesting; being fascinated by gardening cannot be transmuted into an interest in geometry, geography, or goldfish, and we do not assume that because someone is intrinsically motivated to study any of those four that person will also be interested in studying any of the others. One may have intrinsic motivation in many domains, but intrinsic motivation in one domain does not predict intrinsic motivation in other, unrelated domains. Intrinsic motivation remains very domain specific.

It is also easy to forget (or never recognize) that creativity is very domain specific because of the rather loose ways we often talk about creativity. Few of us would ever say "Fred is an expert" without some context that indicated the domain or domains of Fred's expertise, but people often say "Fred is creative" as if that is all that need be said. If someone shows creativity in one area, we are likely to assume—without thinking too deeply about it—that he is probably creative in other areas as well. But if pushed to defend such a claim, we quickly realize that, no, Fred is not really creative across the board. We admire his painting, or his song writing, or his ways of solving puzzles, but we recognize that he is only creative in some domains and not others. And although Fred has probably not done much work in some domains (and thus his creativity is untested), we understand that the skills and personality traits and inspirations that have contributed to his creativity in painting will probably not translate to creativity in engineering or accounting or poetry. For those he will probably need other skills, traits, and inspirations.

We know that creativity is domain specific because our intuitions, if pushed a bit (as I have been pushing them just now), will override our initial, less thoughtful response and tell us it must be so. Creativity must be domain specific or I could use my creativity in designing chemistry experiments to help me write a more imaginative poem, fashion a more interesting sculpture, or invent a more exciting way to turn leftovers into a feast. We know that whatever skills and motivations feed our creativity in one domain cannot be easily transformed into the skills and motivations needed to be creative in other, unrelated domains. We know all of this introspectively, but we also know that creativity is domain specific because of the scores of carefully controlled studies that tell us this.

It is not the goal of this essay to review all of the evidence for domain specificity, which can be found elsewhere (including almost every currently used textbook on creativity; Avitia and Plucker [2014] reviewed all available creativity texts and found that the domain specificity issue was covered in all of them and covered in great detail in most). In the next section I will provide a quick overview of that evidence and suggest some articles and books for more in-depth coverage. But that is just warmup. My primary goal in this essay is to explain why this matters so much. Domain specificity isn't simply an interesting discovery in creativity research and theory. It changes everything we know, or think we know, about creativity.

HOW WE KNOW CREATIVITY IS DOMAIN SPECIFIC

The *Creativity Research Journal* began publication in 1988. In the years since then, it has published just one pair of Point–Counterpoint articles. The topic it deemed so important that it sponsored this debate? Domain specificity (Baer, 1998a; Plucker, 1998). Creativity had long been viewed as a domain-general phenomenon, but by 1998 that assumption was crumbling under the weight of a series of research studies showing that creativity simply does not work that way. Even the author of the Point–Counterpoint article who wrote in favor of domain generality acknowledged the sea change that had occurred:

> Recent observers of the theoretical (Csikszentmihalyi, 1988) and empirical (Gardner, 1993; Runco, 1989; Sternberg & Lubart, 1995) creativity literature could reasonably assume that the debate is settled in favor of content specificity. In fact, Baer (1994a, 1994b, 1994c) provided convincing evidence that creativity is not only content specific but is also task specific within content areas. (Plucker, 1998, p. 179)

This was a nearly 180-degree change from just a decade earlier, when domain generality had simply been assumed to be true in most creativity research, theory, training, and testing. This assumption was so widespread that it was rarely stated explicitly or in any way acknowledged.

The research that led to this profound change in how creativity is understood has taken many forms, but the most widely used approach has been to give subjects a number

of different tasks in different domains (e.g., create a collage, write a poem, write a story); have panels of experts in the respective domains independently rate those products for creativity (most often using the consensual assessment technique; Amabile, 1982, 1983, 1996); and then look for correlations between the ratings in different domains. Domain generality and domain specificity make opposite predictions regarding the kinds of creative performance they expect in such a study. Here's how one creativity researcher succinctly summarized how these predictions would differ:

> Domain generality would be supported by high intercorrelations among different creative behaviors . . . while domain specificity would be supported by relatively low correlations among different behaviors. (Ivcevic, 2007, p. 272)

The correlations that have been reported in the many studies that have made exactly this comparison have tended to hover around zero (especially if variance attributable to intelligence is removed; see Baer, 2010, 2012, in press; for summaries). In one typical study, Baer (1993) asked 50 eighth-grade students to create poems, stories, mathematical word problems, and interesting equations (in which students were asked to create a mathematical equality that they considered especially interesting; see Baer, 1993, pp. 49–52 for complete details). Each student created one poem, one story, one equation, and one word problem. The consensual assessment technique was used to rate the creativity of the various artifacts, with excellent interrater reliabilities (coefficient alpha; Nunnally, 1978) ranging from .78 to .92.

As shown in Table 1, three were positive, three negative, and only one reached a modest .05 level of statistical significance (which disappears if one controls for looking at multiple possible correlations). It was hypothesized that general intellectual ability might add to the cross-domain correlations, so variance attributable to math and verbal standardized test scores was removed. Once again there were again three positive and three negative correlations, this time with a mean correlation of −.05. The only statistically significant correlation was a negative one, as shown in Table 2.

Baer (1991, 1993, 1994a, 1994b) reported similar results with adults, fifth-grade students, fourth-grade students, and second-grade students, and other researchers have produced comparable results using different tasks and populations. The conclusions of such studies have been consistent: correlations of creativity ratings of products within the same domain evidence modest positive correlations, but cross-domain correlations—the ones that test for domain generality—hover close to zero (e.g., Han, 2003; Han & Marvin, 2002; Runco, 1989; Ruscio, Whitney, & Amabile, 1998).

TABLE 1
Correlations Among Creativity Ratings

Task	*Poetry*	*Story*	*Word Problem*	*Equation*
Poetry	—	.23	.31*	−.14
Story		—	.20	−.03
Word Problem			—	−.20

Note. $N = 50$.
*$p < .05$, two-tailed.

TABLE 2
Partial Correlations Among Creativity Ratings

Task	*Poetry*	*Story*	*Word Problem*	*Equation*
Poetry	—	−.01	.19	−.14
Story		—	.05	.07
Word Problem			—	−.45*

Note. $N = 50$.
*$p < .01$, two-tailed.

A study by Conti, Coon, and Amabile (1996) highlights the difference between within-domain and across-domain creativity correlations. Subjects created seven different artifacts in two domains, fiction and art: four story-writing tasks (using different prompts) and three different art activities. The correlations they reported among the story-writing creativity ratings (within-domain correlations) were high (ranging from .43 to .87) and statistically significant, suggesting that these ratings were largely measures of the same domain-based ability. The correlations among the ratings of the art-related tasks were also positive but not as strong, because unlike the writing tasks, which were all very similar (all required subjects to write a short story based on a prompt), the art tasks varied considerably (a collage, a painting, and a drawing).

But it is the across-domain correlations that address the domain generality/specificity question, and here the results were clearcut. Of the 13 correlations, all were tiny, some were positive and some were negative, and none—not one of the 13, even without controlling for the problem of fishing among 13 possible correlations for one that might meet the .05 conventional cutoff—was statistically significant, which means that they provided no evidence whatsoever for domain generality.

But what about polymaths, those amazing people who truly are creative in multiple domains? Here the two theories make similar, but slightly different, predictions. Domain specificity does not argue that a person can only be creative in a single domain, only that creativity in one domain is not predictive of creativity in other domains. When two variables, A and B, are uncorrelated, we do not expect that no one will score high in both. If that were the case, there would be a strong negative correlation. What we expect is that among those who earn high or low scores:

- Some people will be high in A and high in B.
- Some will be high in A and low in B.
- Some will be low in A and high in B.
- Some will be low in A and low in B.

If there are more than two variables, the possibilities become more numerous, but the pattern (or lack of pattern) is the same. If there is a zero correlation among a group of variables, then one expects that some people will be high in many, others will be low in many, and most people will have various mixes of high, average, and low scores (just as if one pulled five marbles out of a bag containing five different colored marbles and did this again and again, one would expect sometimes to pull out several—on rare occasions all five—of the same color).

So domain specificity predicts polymaths, but it also predicts that polymaths will be rare, as, indeed, they are. The existence of creative polymaths provides no evidence against domain specificity. Just the opposite: their existence, and their rarity, are *exactly* what domain specificity predicts. (Domain generality also predicts that there will be polymaths, but it predicts much higher numbers of polymaths than we observe in the world. For more on this question, see Baer, in press; Kaufman, Beghetto, & Baer, 2010; Kaufman, Beghetto, Baer, & Ivcevic, 2010.)

WHY DOMAIN SPECIFICITY MATTERS

"Are you creative?" We now know that one cannot answer this question without more information. "Creative doing what?" Even if you are very creative in many domains, you can be no more across-the-board creative than you can be an all-purpose expert. Creativity and expertise are not at all the same—I'm repeating myself because I think this bears repeating—but one cannot answer the question "Are you creative?" any better than the question "Are you an expert?" without the context of the domain(s) in question. (There may be other qualifications one would need to add, such as time of day, whether working alone or in a group, reward or evaluation contingencies—these and many other factors might shade one's answer to an "Are you creative?" question—but my focus in this essay is on individual differences in creativity depending on domain.)

It is unfortunate, perhaps, that one cannot simply redirect one's cooking creativity in a way that would make one a more creative teacher, poet, or scientist. As with expertise, there may be some minor overlaps (e.g., one's knowledge of spices, a very special kind of expertise mostly of use in cooking, could in special circumstances also be of use in teaching, poetry, or science). But for the most part, creativity is not fungible across domains. One can covert dollars into francs or yen, one can even convert dollars into an incredibly diverse array of objects and services (via purchase, provided that one has enough dollars). But one cannot convert creativity in Domain X into creativity in an unrelated domain, no matter how much creativity one has in Domain X.

What does domain specificity of creativity mean for creativity theory, research, testing, and training? In a word, Everything.

In the exposition below, I will assume that creativity is *entirely* domain specific, but I am doing so only to make the discussion more clear. There may be more minor degrees of domain generality. For example, intelligence, which research has shown to be more domain general than creativity (Neisser et al., 1996), may have an impact on creativity in many domains, which could cause a small domain-general impact on creative performance in many domains. I have elsewhere described a hierarchical model of creativity that allows some very small degree of domain generality across many domains and a larger (but still fairly small) degree of generality across related domains (e.g., creativity in writing fiction shares some skills with creativity in writing essays or plays). Under this model, the more narrowly one defines a domain, the more shared variance there is within that domain (Baer & Kaufman, 2005; Kaufman & Baer, 2005). Small amounts of domain generality, especially domain generality that is limited to a single thematic area (e.g., math–science creativity or performing arts creativity), imposes the same constraints on creativity theory, research, testing, and training, so for the purpose of this essay I will ignore it.

CREATIVITY TRAINING

Let's start with creativity training. Many creativity-training programs implicitly assume that creativity is domain general and that the exercises one uses are mostly a matter of convenience. Increase participants' skill in some creativity-relevant kind of activity (such as divergent thinking) and it will increase their creativity in everything they do.

But if creativity is domain specific, how could that be possible? The answer is easy: it can't be. And research has shown this. The impact of creativity training is very domain specific.

Scott, Leritz, and Mumford (2004) conducted a meta-analysis of all creativity training research over the preceding half century and came the conclusion that "well-designed creativity training programs typically induce gains in performance" (p. 361). The good news is that some programs succeeded in boosting creativity; the bad news is that others did not. The ones that did well were the ones that focused on a single domain: the "more successful programs were likely to focus on development of cognitive skills and the heuristics involved in skill application, using realistic exercises appropriate to the domain at hand" (p. 361). "The most clear-cut finding to emerge in the overall analysis was that the use of domain-based performance exercises was positively related ($r = .31$, $\beta = .35$) to effect size" (p. 380).

Dow and Mayer (2004) considered a smaller range of studies, ones focused only on solving insight problems. In the first sentence of their abstract they explained that it was the question of the domain generality/domain specificity of creativity training that prompted their study:

> The purpose of this research was to investigate whether insight problem solving depends on domain-specific or domain-general problem-solving skills, that is, whether people think in terms of conceptually different types of insight problems. (p. 389)

They acknowledged that creativity training has had a rather spotty record of success, especially when it comes to transfer of the skills learned via training to other domains:

> Training of creative problem solving has a somewhat disappointing history, because learning to solve one kind of problem rarely supports solving of other types of problems (Chase & Simon, 1973; Chi, 1978; Mayer, 1996, 2002; Ripple, 1999; Thorndike, 1906). (Dow & Mayer, 2004, p. 397)

So Dow and Mayer (2004) decided to look inside the broad domain of insight problem solving to see whether the effects of training some subjects how to solve verbal insight problems and of training other subjects how to solve spatial insight problems had an impact on skill or success in (a) solving the kinds of problems used in the training and (b) solving the other kind of insight problems not specifically practiced in the training (that is, did training in solving verbal insight problems increase success in solving spatial insight problems, and vice versa?). Their results were entirely "consistent with the domain-specific theory of insight problem solving, namely, the idea that insight problems are not a unitary general category but rather should be thought of as a collection of distinct types of problems" (Dow & Mayer, 2004, p. 397). Subjects' increased ability to solve one kind of insight problem—skills that showed a very positive effect of training—simply did not transfer to their work on other kinds of insight problems.[2]

> What is learned when someone learns how to solve spatial insight problems? Our research suggests that students learn a general strategy that applies only to a subcategory of insight problems—that is, learning to overcome self-imposed constraints in solving spatial insight problems. We propose that insight problems should not be thought of as a unitary category of problems but rather as a collection of distinct problem types. The distinguishing feature of each problem type is the general strategy that can be used to solve it. Consistent with theories of transfer based on specific transfer of general strategies (Mayer, 2002; Singley & Anderson, 1989), when one learns how to solve spatial insight problems one learns a general strategy that applies to other spatial insight problems but not to mathematical or verbal problems. What enables transfer is that the to-be-solved problem requires the same general solution strategy as a source problem that the learner already knows how to solve. (Dow & Mayer, p. 391)

Baer (1996) directly tested the effects of training related to creativity in one domain with creative performance both in that domain and in a different but seemingly related domain. Middle-school students in the experimental group spent several hours working on a variety of divergent-thinking activities related to poetry-writing creativity, such as brainstorming words that could stand for other words or ideas (metaphor production). Control group students had unrelated training. One week later, both groups wrote poems and short stories in their regular language arts classes. Poems written by the students who received the poetry-relevant divergent-thinking training received higher creativity ratings from experts than poems written by students in the control group (so the training worked). This training did *not* help them write more creative stories than students in the control group, however, even though poetry-writing and story-writing would seem to come from the same larger domain of writing (so the effects of the training were *very* domain specific). This need for subdomain specificity to properly gauge the effects of creativity training echoes what Pretz and McCollum (2014) wrote about the need for extremely domain-specific analyses: "Perhaps prior studies of domain-specific creativity were not specific enough" (p. 233).

The effects of creativity training are *very* domain specific. Should this surprise us? Isn't this how most training works? If one could strengthen all of one's muscles with a single kind of exercise it would make for shorter workouts, but (sadly) strengthening one's biceps will not make one's quadriceps much stronger. To increase one's physical strength overall, one needs to do many different kinds of exercises that work on different muscles and muscle groups. Similarly, to improve one's creative-thinking skills across many domains, one needs to work on and strengthen those skills in many domains.

Once again, the parallel with expertise is helpful. We know that expertise is domain specific, so we know that the kinds of education, training, or practice needed to develop expertise will be different in different domains. Studying quantum physics will help develop expertise in that area but do nothing for one's expertise in Japanese history, Elizabethan drama, or reading the break on putting greens.

If one's goal is to increase creativity in just one domain, such as teachers might want to do in a gifted program focusing on a single discipline (e.g., a program in music, poetry, math, etc.), then it would make sense for all of the creativity-training exercises to use content from that domain. If one's goal is to increase creativity in multiple domains, however, one needs to use a wide range of domains in training. A program that aims at training creativity more generally can only do so by training creativity in many domains (just as a program designed to improve overall strength would involve exercising a wide variety of muscles, not a single set of muscles). There is no generic set of creative-thinking skills one can develop that will boost creativity across the board any more than there is one kind of expertise one might acquire that would make one an expert in all (or even most) domains.

This does not mean that creativity training in each domain must be conducted separately. Just as one can exercise multiple muscles at the same time with some exercises and a teacher can include language arts, history, science, and math in the same unit of study or project, one can in some cases work on multiple creative-thinking skills as part of the same training activity. What one cannot do, however, is teach creative-thinking skills in one domain and get them to transfer to other domains. Creativity training, like the development of expertise and musculature, just isn't that easy.

Creativity training needs to address the issue of domain specificity. Trainers can then decided whether they want to help participants (a) become more creative in a specific domain or (b) become more creative in multiple domains—and then choose the training activities and plan the sessions accordingly. One can, of course, ignore the domain specificity of creativity in one's training activities, but doing so won't make one's training any more domain general. It will just make its effects more disappointing.

CREATIVITY ASSESSMENT

Because creativity is domain specific, creativity assessment must also be domain specific. One might put together a battery of domain-specific assessments and argue that average scores on these assessments could be used as an overall creativity index (just as one might assess expertise in diverse domains and produce a mean expertise index), but to do this one must first develop and validate each of the domain-specific assessments. Having done that, why would anyone want to agglomerate those scores? Having scores on the domain-specific measures would be both more meaningful and more useful than a sum that would (a) throw away most of what one has learned from the domain-specific assessments by making each just a part of an ill-defined hodgepodge (e.g., What would a sum of a person's creativity in set design, creativity in geometry, and creativity in gymnastics possibly mean?) and (b) be easy to challenge as a measure of general creativity (because why use any particular combination of domain-specific assessments?).

There are, of course, so-called creativity tests that claim to measure domain-general creativity. The most widely used of these are the two Torrance Tests of Creative Thinking (TTCT), which attempt to measure divergent-thinking skill in two domains, verbal and figural. There has been much debate about the validity of these tests over their half-century history; in fact, when Division 10 of the American Psychological Association (Psychology of Aesthetics, Creativity, and the Arts) held its first-ever debate, the topic it chose was "Are the Torrance Tests still relevant in the 21st century?" (Baer, 2009; Kim, 2009). The division followed this 2 years later by publication of a somewhat extended debate on the same topic in the division's journal, *Psychology of Aesthetics, Creativity, and the Arts* (Baer, 2011a, 2011b; Kim, 2011a, 2011b). The future of these tests—whether they have any future at all in the 21st century—is clearly in doubt.

There have been validation efforts of these tests that have succeeded, and validation efforts that have failed (for details, see Baer, 1993, 2010, in press). I will focus here only on the ones that have claimed success in order to show the limitations of those claims—limitations attributable entirely to the domain specificity of creativity.

Most of the successful validations of the TTCT have been based on longitudinal studies conducted by Torrance himself. These have been critiqued endlessly, with diverse writers complaining about the kinds of measures used as criteria of posttest (real-word) creativity, things like subscribing to a professional journal, learning a new language, or changing religious affiliation. Torrance (1972) complained (fairly, I believe) when studies by other investigators failed to show a correlation between his tests and such things as course grades and classroom misbehavior. What do course grades and classroom behavior tell us about creativity? But what is good for the goose is good for the gander, and the measures Torrance used as evidence of real-world creativity looked to critics just as cherry-picked as those used in studies where the TTCT failed to correlate with the creativity criteria. Both kinds of evidence suffered from the same problem: They only convinced those who already believed what those particular criteria seemed to tell us about the Torrance Tests. Fans of the tests accepted Torrance's measures but not those by critics, whereas doubters accepted the measures used by doubters but not those used by Torrance.

In addition to problems with the validation studies (more about validation issues below), there are two other kinds of problems with Torrance's studies. First, they used mostly self-report data, which is notoriously unreliable in general (Dunning, 2012; Dunning, Johnson, Ehrlinger, & Kruger, 2003; Kruger, 1999; Zell & Krizan, 2014), and perhaps especially in creativity self-assessment (Brown, 1989; Hocevar, 1981; Kaufman, Evans, & Baer, 2010; Michael & Wright, 1989; Pretz & McCollum, 2014; Reiter-Palmon, Robinson, Kaufman, & Santo, 2012; Silvia, Wigert, Reiter-Palmon, & Kaufman, 2012).[3] Second, the two different tests Torrance created were themselves essentially orthogonal, meaning that they measured entirely different constructs (Torrance himself reported a correlation of just .06, according to Cramond, Matthews-Morgan, Bandalos, & Zuo, 2005).[4]

Plucker (1999) recently reanalyzed one of the most highly cited studies that Torrance conducted using both Verbal and Figural Forms of the Torrance Tests. He argued that this study provided the "most compelling" evidence for validly of the Torrance tests and that "Any analysis of this topic should begin with this seminal study" (p. 104). What did he find? Verbal test scores were indeed a powerful predictor of the kinds of things used as criterion measures (indicators of creativity, which were, again, self-reported data), but Figural Torrance Test scores were not.

The difference in the predictive ability of the two Torrance Tests is interesting, and Plucker was at a loss to explain why one of the Torrance Tests—the Verbal Test—predicted creativity but the other Torrance Test—the Figural Test—did not. This is hard to understand if one thinks of the two tests as equivalent domain-general measures of creativity (which is how they are routinely used). If creativity is domain specific, however, the explanation for why a Verbal Test would predict creative performance on these kinds of measures but a Figural Test would not is both easy and obvious. Although Plucker didn't frame his discussion of this discrepancy in terms of domain specificity, that is what his explanation boiled down to:

> The importance of verbal DT relative to figural DT may be due to a linguistic bias in the adult creative achievement checklists. For example, if a majority of the creative achievements required a high degree of linguistic talent, as opposed to spatial talent or problem solving talents, the verbal DT tests would be expected to have a significantly higher correlation to these types of achievement than other forms of DT. (Plucker, 1999, p. 110)

So even the best evidence for validity of the Torrance Tests validates only one of the two tests, and it does so in a way that makes a strong case for domain specificity.

Domain-general tests of creativity continue to be used, especially for admission to gifted/talented programs looking desperately for something to use other than IQ and achievement test scores, and I applaud the desire to include a measure of creativity as a criterion in evaluating candidates for G/T or other programs. But wanting a test to be valid does not make it valid. Csikszentmihalyi (1996) observed that, "If one turns to the literature of creativity research and asks the simple question: What is being measured? What is creativity? One soon realizes that the entire research enterprise moves on very thin ice" (p. 143).

Sawyer's (2012) summary of the results of more than a half-century of work in creativity test development was similarly pessimistic:

> Different tests, each designed to measure creativity, often aren't correlated with one another, thus failing to demonstrate convergent validity. Another problem is that even though some of these tests correlate with creative achievement, the tests might in fact correlate with *all* achievement. Rather than measuring creativity, they might be measuring success and social achievement more generally—and IQ tests probably do a better job of that. (p. 61, italics in original)

What kind of creativity assessment can possibly be valid, given the domain specificity of creativity? The answer is simple: Domain-specific tests that measure creativity in the domain(s) of interest and do not pretend to say anything about creativity in general. For example, the consensual assessment technique is based on the idea that the best measure of the creativity of a work of art, a theory, a research proposal, or any other artifact is the combined assessment of experts in that field, and for this reason—and unlike all other measures of creativity currently being used—the consensual assessment technique is not based on any particular theory of creativity. This means that its validity (which has been well established empirically) is not dependent upon the validity of any particular theory of creativity. The consensual assessment technique has been deemed the "gold standard" in creativity research (Carson, 2006) and can be very useful in creativity assessment in educational settings as well.[5]

The consensual assessment technique is, in one sense, a very simple technique. Participants make something, and experts in the domain are then asked to judge the creativity of those things, based on their sense of what is creative in their field and without any instructions about what creativity means. The judges work independently of one another—they don't discuss their ratings, learn about other experts' ratings, or compare ratings with other judges in any way—and they consider the same group of creative products, judging their creativity in comparison to other items in the group. The creativity "score" is simply the mean creativity ratings of these panels of experts, typically on a Likert-type rating scale. With even a modest number of judges, interrater reliability is generally quite good (Amabile, 1982, 1983, 1996; Baer, 1993, in press; Baer, Kaufman, & Gentile, 2004).

The consensual assessment technique is fairly new, although in a sense this is how creativity has always been judged. Nobel Prize committees rely in experts in each domain, as do most other prize-awarding committees, and this was the norm long before psychologists started assessing creativity. It was operationalized as a psychological research tool by Amabile in 1982 and further developed by her and other researchers in the last quarter century (Amabile, 1982, 1983, 1996; Baer, 1993, 1994a, 1994c; Baer et al., 2004; Baer & McKool, 2009, 2014; Hennessey, 1994; Kaufman, Baer, Cole, & Sexton, 2008; Kaufman, Baer, Cropley, Reiter-Palmon, & Sinnett, 2013; Kaufman, Baer, & Skidmore, 2013; Kaufman, Cole, & Baer, 2009; Kaufman, Gentile, & Baer, 2005).

The consensual assessment technique has been employed in studies with widely varying goals, such as:

- analyzing ways that people with different levels of expertise in a domain conceptualize creativity differently (e.g., Kaufman et al., 2005, 2008);
- comparing and evaluating domain-general and domain-specific models of creativity (e.g., Baer, 1993; Conti et al., 1996; Runco, 1987; Ruscio et al., 1998);
- comparing creative performance under different (intrinsic v. extrinsic) motivational constraints (e.g., Amabile, 1983, 1996);
- investigating the long-term stability of creativity in a given domain (e.g., Baer, 1994c);

- looking at creativity in cross-cultural settings (e.g., Niu, 2007; Niu & Sternberg, 2001);
- looking for possible gender and ethnicity differences in creativity (e.g., Kaufman, Baer, & Gentile, 2004);
- measuring the impact of teaching different skills and content knowledge on creative performance (e.g., Baer, 1993, 2003);
- studying how varying motivational constraints influence the creativity of boys and girls differently (e.g., Baer, 1997, 1998b); and
- studying the relationship between process and product in creativity (e.g., Hennessey, 1994).

Other less resource-intensive measures of domain-specific creativity could be developed in the future (even divergent-thinking tests like the TTCT but limited in application and prediction to a single domain). Domain-general creativity tests cannot possibly be of much value, given (a) the overwhelming mass of research evidence showing that creativity is largely domain specific and (b) the psychometric failures of such tests. But solving the problem of invalid domain-general tests of creativity is not as simple as ceasing to use them (although that would be a good start). The problem is that much of what we think we have learned from decades of creativity research—using what we now know to be invalid tests—may simply not be true.

CREATIVITY RESEARCH

This section will be short, and its key message was already delivered in the closing sentence of the previous paragraph: much of what we think we know, from decades of creativity research using what we now know to be invalid tests, may simply not be true.

In 1984, Torrance and Presbury conducted a comprehensive survey of creativity research. They reported that at least one of the Torrance Tests was used in fully three quarters of all published studies of creativity that used students as subjects (and 40% of the much smaller number of creativity studies with adults). The Torrance Tests dominated the field of creativity research to such an extent 30 years ago that, in what was intended as a comprehensive meta-analytic evaluation of the long-term effects of various creativity training programs, only studies that used one of the Torrance Tests were included (Rose & Lin, 1984). But as the previous section showed, these tests are, at best, only measures of divergent-thinking skill in specific domains. Any claims of any research based on these tests is therefore called into question. Things we might have thought we had learned, things that have become widely accepted in the field, may not be true.

Observers of creativity research over many years will probably not find this claim all that surprising. The field is rife with results that conflict with other results. One likely explanation for these many discrepancies is domain specificity. What is true of creativity in one domain may simply not be true in other domains, and the outcome of a research study is likely to depend far more on which test the experimenters happened to use than anything about the nature of creativity. (Want a different result? Just try a different test of creativity.)

To the extent that creativity is domain specific, it is difficult, if not impossible, to make broad claims about the nature of creativity. Expertise is also domain specific, and there are still things we can say about expertise in general (for example, that it takes significant amounts of time to acquire expertise, and that deliberate study or practice is usually necessary). But most of the claims one can make about expertise depend on the domain of the expertise; expertise in auto mechanics and cake decorating have little overlap.

Domain specificity similarly limits the kinds of claims one can make about creativity unless one specifies the domain. For example, there is much conflicting evidence regarding the claim that creativity is associated with mental illnesses. If one limits one's research about mental illness and creativity to specific domains, however, the picture becomes much clearer (e.g., creativity in science at the highest levels is not generally associated statistically with mental illness, but creativity in poetry at such levels is; Kaufman, 2001a, 2001b; Kaufman & Baer, 2002; Simonton, 2010).

Here is one less well-known example of how domains matter in creativity research. Gardner and Davis (2013; see also Weinstein, Clark, DiBartlomomeo, & Davis, 2014) examined the impact of apps on adolescents' creativity.

> Rather than look at scores on tests of creativity or its correlates (like play), we chose to examine the actual creative productions of young people. . . . To that end, we conducted an extensive analysis of short stories and visual art created by middle and high school students between 1990 and 2011. (Gardner & Davis, 2013, p. 130)

This included "an extensive analysis of 354 pieces of visual art published over a twenty-year period in *Teen Ink,* a national teen literature and art magazine" (Gardner & Davis, 2013, pp. 130–131).

Their analysis revealed a notable increase in the complexity and creativity of adolescent artwork published between 1990 and 2011. But over the same period, the creative writing of adolescents had changed in exactly the opposite direction, becoming less imaginative and more conventional.

"Considered together, these changes in genre, plot, story arc, and time period suggest that, while teens' visual art has become less conventional over time, creative writing emanating from this age group has become more so" (Gardner & Davis, 2013, p. 135). Based on this very compelling body of evidence, the rise and fall of creativity in the same cohorts of teens moved in different directions in the two domains of visual art and creative writing. Over a 21-year period,

adolescent creativity in artwork increased, whereas adolescent creativity in writing decreased. There may be many explanations for this simultaneous rise and fall of creativity (interested readers can review these possible explanations in Gardner and Davis's [2013] book), but from a domain specificity perspective it is not surprising that these two would not be in sync. That's a 50–50 expectation if creativity is domain specific but would be hard to comprehend if creativity were domain general.

Gardner and Davis's (2013) conclusion about the impact of apps on creativity in adolescents was, essentially, that it depends on the domains:

> In the spirit of Marshal McLuhan, we've described how imagination with respect to one medium (graphic expression) is more likely to be enhanced than imagination with respect to another medium (literary expression). When it comes to the matter of creativity, the medium matters. (pp. 153–154)

This is what domain specificity means for creativity research: research must be conducted domain by domain. It is harder work than giving a so-called creativity test and claiming one has learned something about creativity in general, but it has one significant advantage over research with a domain-general focus: It has the very real possibility of being valid.[6]

CREATIVITY THEORY

The impact on theory is, in some ways, obvious. Domain specificity and domain generality are themselves theories about how creativity works. But it is not just these opposing theories that are at stake. Domain specificity is theory of a special kind. It puts constraints on just about every other theory of creativity. It claims that *any* creativity theory must specify the domain(s) to which it applies.

Does this mean that nothing can be said about creativity in general? No, although it does limit what can be said about creativity in general. A comparison to expertise is (again) instructive. There are things one can say about expertise in general, but most of what is of interest regarding expertise has to do with expertise in a particular domain. In most domains expertise requires years of study and practice (although not all; one can become an expert in Tic-Tac-Toe, or other narrowly circumscribed domains, rather easily). Similarly, there are things that seem to be true of creativity across most domains, such as the need for at least limited expertise to make a significant contribution (but this, too, will surely vary across domains).

There are theories of creativity that may be true in many domains and yet still be very domain specific. Amabile's theory of the importance of intrinsic motivation may be true in many domains (although it is hard to say in which domains without running the appropriate studies),[7] but even if this is true, that doesn't make intrinsic motivation a domain-general attribute, as explained earlier. (One can't convert intrinsic motivation in one domain into intrinsic motivation in any other domain. If that were possible, teaching would be *so* much easier! Just find out what students find really interesting and have them apply that interest to, say, diagramming sentences.)

Similarly, it may be that divergent thinking is helpful in many domains (again, one cannot say which domains without doing the appropriate research), but divergent thinking would still be a very domain-specific skill. (Coming up with many varied and unusual ways to use a brick is not the same as coming up with may varied and unusual ways to perform a celebratory dance, write a poem about Halloween, or design a chemistry experiment.) Ditto for such widely discussed ideas as

- openness to experience, which may matter in some, possibly even many, domains (Feist, 1998), but being open to new experiences in one domain says nothing about openness to experience in other domains; one may be intrigued by every imaginable idea when it comes to ways to improve energy efficiency but have little interest in new ideas about clothing fashions;
- tolerance of ambiguity, which in some domains is perhaps a plus for creativity, in others a minus (Furnham & Marks, 2013; Merrotsy, 2013); and one can be very tolerant of ambiguity in one domain and have no patience for it at all in others; and so on.

There may be many things that, at a sufficiently abstract level, influence creative performance in many domains, just as expertise, as an abstract concept, probably influences creativity in many domains. But what kinds of expertise (or other abstract idea), and in which domains? These are huge areas for future theory and research—after we brush away the many cobwebs left by years of invalid research based on domain-general theories and methods of creativity assessment. I'm delighted that the *Roeper Review* will be publishing a series of articles about expertise in a variety of domains. This is much needed and will be an important contribution to the field.

IS IT POSSIBLE TO HAVE TOO MUCH EXPERTISE?

To reach the highest levels of creativity seems almost always to require significant amounts of expertise. Gruber and Davis (1988) claimed that "Perhaps the single most reliable finding in our studies is that creative work takes a long time" (p. 264). This extended period of intense preparation must be spent in "deliberate practice and the development of expert

performance" (Weisberg, 1999, p. 233). But can expertise also diminish creativity?

Like any other question about creativity, this one must be answered on a domain-by-domain basis. The content of expertise needed for creative performance will, of course, vary across domains, but so might the need for expertise itself (or at least the need for high levels of expertise). Observing the need for expertise in many areas does not guarantee a similar need in all areas, even if one is positing only the need for domain-specific expertise. It may be possible to be highly creative in some fields with only a passing familiarity with previous work, whereas expertise of the highest caliber might be required to contribute significantly in other fields (which might explain, at least in part, the varying ages at which peak creativity is typically reached in different fields; Simonton, 1988).

It seems likely that in some domains more expertise will be required than in others to make creative contributions, and there is also the question of the level of the creativity (Big-C, little-c). Almost by definition it is impossible to have too much domain-specific creativity-promoting skills or traits (because whatever skills or traits did not contribute to creativity would not be promoting creativity), but it is not hard to find examples of situations in which knowing a lot seemed to block creative thinking or problem-solving. Functional fixedness—such as not being able to see alternate uses for an object because of one's familiarity with its typical use—is based on the idea that knowledge can block creative thinking.

It is certainly not uncommon for someone with a great deal of expertise in a domain to lack creativity in that domain, but that is not really evidence that expertise is in any way interfering with creative thinking. Expertise and creativity are different things, even if expertise in a domain (generally) makes creativity more likely. One can certainly become so committed to the way things have always been done—or simply too busy learning how things are usually done—that discovering new ideas about how to do things become unlikely.

But the most likely "too much expertise" explanation should really be "too much expertise of a limited kind." It may not be having too much expertise, but of having *only* that expertise and no other, that gets in the way. The fact that creativity is domain specific in no way invalidates the observation that many creative ideas are imported, often as metaphors, from other domains. To be able to see how such imported ideas, such metaphors, might apply in another domain requires expertise in the domain into which they are being imported, and it also requires enough expertise in the domain from which the metaphor originated to at least know about it. The kinds of expertise needed to make a creative contribution in a given domain may sometimes, therefore, include expertise in other, unrelated domains. Which brings us to the question of interdisciplinary thinking.

What Does Domain Specificity Mean for Interdisciplinary Thinking, Interdisciplinary Collaboration, and Interdisciplinary Creativity?

The domain specificity of creativity means that interdisciplinary thinking, interdisciplinary collaboration, and interdisciplinary creativity are even more important than one would assume if creativity were domain general. One cannot simply transfer expertise from one domain to another, unrelated domain—one's expertise in Edo art will be of little use in reading computed tomography scans—nor can one simply transfer skills, motivations, personality traits, or other creativity-relevant factors from one domain to another. Domain specificity does not mean that projects that demand interdisciplinary solutions disappear, but it does help us understand the need for multiple skills, insights, and expertise in solving many problems.

Interdisciplinary thinking is not simply transporting one's knowledge or skills or ways of approaching problems in one domain to some other, unrelated domain. Trying to do that without understanding the target domain is a recipe for failure. If one has expertise and creative problem-solving skills in multiple domains (either as an individual or a team), however, one may be able to find or construct ways of combining those diverse domain-specific skills and bodies of knowledge. Having multiple areas of expertise and diverse domain-specific problem-solving skills may allow a team or an individual to recognize ways of solving problems that would not be possible if one had expertise and skill in only one domain. Domain specificity puts a premium on having multiple domain-based skills and areas of expertise, to solve both (a) problems in a single domain that might benefit from ideas from other domains and (b) problems that are multidisciplinary in nature (such as global warming, an issue that incudes elements—and will require expertise—in multiple domains).

Domain specificity does show why novices in a domain whose expertise lies elsewhere often make what might be called rookie mistakes. Without domain-based expertise, it is all too easy to invent (or unknowingly reinvent) a nonworking wheel. That is not an argument against trying to apply ideas from one domain in a different domain. It is an argument for humility when one approaches a new domain, however. The necessary degree of domain-specific expertise and problem-solving skills will vary across domains, and the need for such skills and knowledge will also vary depending on the particular problem one is trying to solve. Ignorance is rarely if ever an advantage. In contrast, having knowledge of multiple domains, both domains that are similar and domains that are very unlike the area in which one is working, will almost always be an advantage. Which is why interdisciplinary creative problem solving that can bring a wide range of domain-specific expertise and creative-thinking skills to bear on a problem—whether that interdisciplinary effort is

undertaken by an individual or by a group—is often needed to solve our most complex and vexing challenges.

NOTES

1. There is evidence that intelligence, or whatever it is that IQ tests measure, is fairly domain general in the sense that it is correlated with performance in a wide variety of domains (Neisser et al., 1996), but as we will see, that is not true of any so-called tests of creativity.
2. Recent research suggests that skill in insight problem solving may have very little in common with real-world creative behavior, which presents another level of domain specificity. Beaty, Nusbaum, and Silvia (2014) looked at the correlations between success at solving two classic insight problems and real-world creative achievement and concluded that there was "no evidence for a relationship between insight problem solving behavior and creative behavior and achievement" (p. 287).
3. As a good summary judgment of the validity of creativity self-assessments, Reiter-Palmon et al. (2012) concluded that

> Analyses provided evidence of domain specificity of self-perceptions [of creativity]. The scales correlated with self-report measures of creativity, but not with objective measures. Self-perceptions of creativity had strong to moderate relationships with personality and creative self-efficacy. These results suggest that although self-perceptions of creativity may provide some information about creativity, researchers should be cautious when using this measure as a criterion. (p. 107)

4. Imagine giving two IQ tests and finding that the tests were essentially uncorrelated with each other (as Torrance himself found for his two eponymous Figural and Verbal tests). Even if the two intelligence tests were extremely different in format, such as Raven's Progressive Matrices and the Wechsler Adult Intelligence Scale–Revised (WAIS-R), one would expect at least a moderate to strong correlation between them and similar predictive abilities for achievements that IQ scores are expected to predict (which is exactly what one finds for the WAIS-R and Raven's progressive matrices; Bingham, Burke, & Murray, 1966; Kern, Bordieri, & Taylor, 1993; Vincent & Cox, 1974). If one did find such a lack of expected correlation and a pattern of predictive failures, psychometricians would conclude that the two tests were not measuring the same things and that one or both must be invalid measures. They would certainly not try to explain away such discrepant findings while continuing to use both IQ tests, virtually interchangeably, as measures of intelligence. But this is precisely what has happened with the Torrance Tests.
5. As noted in the early section on How We Know Creativity Is Domain Specific, these assessments tend to show good stability—subjects' creativity ratings within a domain tend to be stable across similar assessments and over time—but show virtually zero across-domain correlations, strong evidence of the domain specificity of creativity.
6. Weinstein et al. (2014) compared their research results (the same ones reported in Gardner and Davis's [2013] book) with a study that made the cover of *Newsweek* magazine in 2010 (Bronson & Merryman, 2010) that argued that creativity was in decline, based on changes in scores on one of the Torrance Tests over roughly the same period of time. "The Creativity Crisis" was the title of the *Newsweek* cover (15 July 2010). Weinstein et al. (2014) concluded, based on the results of their longitudinal study of *actual* creative performance of adolescents in two different domains, that the answer to the question "Is creativity in crisis?" cannot be answered globally, as *Newsweek* and the Torrance Test study argued, but must instead be asked, and answered, on a domain-by-domain basis because "[i]t depends on where one looks. With so much at stake, creativity research seeking to document and explain putative trends in creativity is well advised to use a variety of measures and a variety of media as creatively as possible" (p. 183). Weinstein et al. (2014) titled their study "A Decline in Creativity? It Depends on the Domain," and in explaining their research design noted that "there is considerable support for the notion of domain specificity related to creativity" (p. 175) and quoted Runco's (2004) *Annual Review of Psychology* entry on "Creativity" to emphasize this point: Runco (2004) suggested that the concept of domains "must be acknowledged because most of what has been uncovered about creativity is domain specific" (p. 678). Further, Runco suggested that considering and elucidating differences across domains is "one of the most important impetuses in the literature" (p. 678). To understand how creativity is actually changing in different domains, it is imperative that research considers the products of those domains. (p. 175).
7. Domain specificity may be part of the reason for the many contradictory studies in this area, some showing a pronounced negative impact of extrinsic motivation, others showing a positive impact or no impact (see, e.g., Amabile, 1983, 1996; Baer, 1997, 1998b; Conti, Collins, & Picariello, 2001; Eisenberger & Cameron, 1996; Eisenberger & Rhoades, 2001; and Eisenberger & Shanock, 2003). Extrinsic motivation might decrease creativity in some domains and increase it or have no impact in others.

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