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# Are Some People Generally More Creative Than Others? A Systematic Review of Fifty Years' Research.

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## **Abstract**

Many recent studies support the idea that creativity is partially or totally “domain-general”. Certain individuals may exhibit greater creativity than the average, whatever the domain. More precisely, certain general factors (*e.g.*, genetic factors, creative personality) could significantly impact creativity. This systematic review aims to evaluate this latter assertion. All empirical papers using at least two creative performance tasks in two domains were selected ( $n = 36$ ). Results show that some participants succeed in creative tasks in several different domains, but only in experiments where specific prior knowledge is not controlled and tasks are artificial. Furthermore, certain studies conflate the function, which is domain-general, with its functioning, which may not necessarily be domain-general. For these reasons, the results appear less robust (no control for confounding factors) and less representative (creative tasks are not academically, socially or professionally realistic). Therefore, it seems premature to recommend the integration of general creative skills into school or training programs, as well as the selection of students or employees with a presumed “creative profile”.

## Introduction

The vast majority of Human beings cannot be creative in all domains, but only in those they master. In this sense, creativity is not “domain-general” but exclusively “domain-specific” (He & Wong, 2021; Barbot, 2018; Huang et al., 2017; Schindler & Rott, 2017; Lunke & Meier, 2016; Furley & Memmert, 2015; Boccia et al., 2015). As domain specific knowledge, it is possible to teach it and to learn it (Tricot & Sweller, 2014). More accurately, creativity is a general process (based on the production of random solutions), but it requires domain-specific knowledge (about the problem itself) to produce a relevant solution (Sweller, 2009).

Nevertheless, some people seem more creative than the average. They have particular personality traits (Jonason et al., 2017). For instance, they tend to prefer creative hobbies (An & Runco, 2016) and are very inventive in all situations of ordinary life (Runco et al., 2005). They are less conformist than their fellows. In brief, they give the impression of being spontaneously creative in all domains. Is this the case? Are some people generally more creative than others? What does the research say?

### *The domain-general hypothesis*

“Creativity is the ability of an individual to produce a novel and appropriate product” (Tong et al., 2022, p. 1). For instance, the new solution proposed must solve the problem raised. It is not just about being original. In addition, according to the “Four-c model of creativity” (Kaufman & Beghetto, 2009), there are four levels of creativity: “mini-c”, “little-c”, “pro-c” and “big-c”. First of all, a creation can be uniquely new to the creator. All you have to do is learning to become the equal of a mini-creator. “mini-c (...) encompass the creativity inherent in the learning process” (Kaufman & Beghetto, 2009, p. 3). To be a little-creator, it is not enough to learn. You also have to make your work stand out from what a novice or even an amateur can usually produce (even if it does not require much effort on your part): “the little-c category is useful for the everyday creativity of the home cook who can creatively combine ingredients to develop unique and tasty meals” (Kaufman & Beghetto, 2009, p. 3). To be a pro-creator, you do not need to make it a job, but you have to devote many hours a day over a period of ten years or so, and constantly strive to improve (with access to relevant information). To be a big-creator (like Einstein, Darwin, Mozart, De Vinci, etc.), not only do you have to be a professional, you also have to make history. A big-creator must still appear as a genius to “the gatekeepers who comprise the field – the professors, the editors, the critics, the historians” (Kaufman & Beghetto, 2009, p. 4).

In short, this classification distinguishes four degrees of creativity: the learner’s mini-creativity (any learning is a mini-creation), the little-creativity of the amateur (requiring little or no investment compared to pro-c creativity), the pro-creativity of the professional (involving at least 10 years of daily efforts to progress) and the big-creativity of the genius (involving at least 10 years of daily efforts to progress, revolutionizing a field and making definitive history). Therefore, for no researcher is it possible to be a major creator (Big-C) or even an inventive professional (Pro-c) without lengthy training.

Nonetheless, certain persons might have a creative mindset: (1) some may be endowed with a partially or totally innate creative personality; in other words, they have a deep taste for creativity in general (in addition to their taste for this or that particular domain); (2) this personality gives them an undeniable advantage in *any* creative learning (they will seek to be creative in their preferred domain and will invest themselves in it more than others). As Nietzsche wrote (2014[1886-7]), some people have a "slave mentality" (conformist) and others a "master mentality" (non-conformist). Some want to create for the sake of creating, even if they end up preferring a particular domain; their preference for one area is merely a pretext, an opportunity to be creative in an efficient way. Dali is perhaps still one of the symbols of this state of mind. This famous Spanish artist did not just create paintings and sculptures for art lovers. Every room in his house is a work of art filled with works of art. It is as if he could not walk through his garden without transforming it. Every human activity seems to him an opportunity to create. In this perspective, there may be mini-c, little-c, pro-c or big-c people who are more likely to be creative than the average in any domain. In sum, creativity can be domain-general: the time-consuming acquisition of specific knowledge only serves to concretize a general tendency (a strong penchant for all things creative).

This idea is quite old. At the end of the 90s, Plucker (1998, p. 179) was already asserting that: "Researchers approaching creativity (especially divergent thinking) from a psychometric perspective over the past 50 years have worked under the assumption that creativity is content general." A wealth of data collected since the 1950s would suggest that creativity is not an isolated behavior, and the data would have remained largely consistent on this point to the present day. "In summary, the existing evidence for domain specificity does not seem to be convincing" (Qian et al., 2019, p. 2). For example, a person can have the same specific knowledge as another and still not be creative. In this case, creativity is not domain-specific knowledge added to other expert knowledge. It is more akin to a state of mind that transcends domains (the desire to innovate; see also Joy, 2008) or to a general set of skills: trial-and-error methodology, the idea of drawing inspiration from fields outside one's own, and so on. The material is specific, but the will and the principal tools are general. To put it differently, in the "hybrid conceptualization" proposed by Plucker and Beghetto in 2004 (see also Sternberg, 1989), an individual who possesses only specific knowledge cannot be creative: "someone who focuses tightly for long periods of time in a domain or in a particular task is likely to experiment functional fixedness" (Plucker & Beghetto, 2004, p. 161). To become creative again, it must necessarily return to a more "generalist", less "specific", less specialized mentality. In this approach, specific knowledge can be used to pose a research problem and evaluate a solution. It cannot be used to produce a solution, i.e. to create a solution (the desire to innovate remains domain-general). There may be a will to make sculptures (*e.g.*, a simple urge to reproduce sculptures), but there is no will to *create* sculptures; there is only a general will to create.

As we will see in more detail later, not all advocates of the hybrid position are so radical. Many of them recognize the decisive *creative* role played by specific tools (*e.g.*, schematization in mathematical problem-solving) and even by specific desires (*e.g.*, wanting to create only sculptures). "Recently, increasing

studies have suggested that creativity can be viewed as both domain-general and domain-specific” (Teng et al., 2022, p. 55). Creativity is therefore more or less general, depending on the author: as the impact of specific factors on creativity increases, the generality of creativity decreases; it only becomes zero if there are no longer any factors likely to increase creativity in any field (i.e., to have a “positive” impact on creativity in any domain). It is therefore currently possible to reformulate the domain-general hypothesis as follows:

- Creativity (mini-c, little-c, pro-c, big-c) is “domain-general” (or “domain-general and domain-specific” or “hybrid”) if and only if there is at least one general factor (*e.g.*, creative personality, general creative strategy such as brainstorming) likely to have a significant positive impact on creative performance in any domain (general factors likely to have an essentially negative impact, such as brain damage, are not taken into account in this study).

More precisely, this impact has to be at least statistically “weak” (*e.g.*, Cohen's  $d \geq 0.2$ ) according to current standards. Otherwise, this impact is negligible, and creativity cannot be scientifically described as domain-general. For the sake of convenience, we will say that this positive impact must be “non-negligible”. What general factors seem non-negligible at first glance?

#### *The mechanist domain-general model*

Neuroscientific studies show that two domain-general mechanisms underlie creative thinking: the “default mode network” and the “executive control network” (for a review, see Chen et al., 2023). The first can freely associate words, images, concepts, etc. The second controls this association process. It evaluates, for example, the relevance of the produced associations. The interactions between these two cognitive functions allow the cognitive system to create new and adapted solutions.

In other words, creativity is domain-general because the creative mechanisms (default mode and executive control networks) are the same, whatever the domain. This idea was already implicit in earlier psychological studies. “Early behavioral evidence suggested that creative thinking is a domain-general ability, involving the same basic cognitive processes (such as remote association-making and divergent thinking) in different domains (Plucker, 1998; Plucker and Beghetto, 2004)” (Chen et al., 2023, p. 1). Ultimately, neuroscience simply locates these processes in the brain and specifies their content: “we hold that neuroimaging studies may offer a way to clarify the domain-general vs domain-specific nature of creative thinking since they can more directly examine the cognitive processes that operate during creative tasks” (Chen et al., 2023, p. 2). In brief:

- (the mechanist domain-general hypothesis) Creativity is domain-general if the cognitive or neural mechanisms involved in creative tasks are domain-general (the mechanisms are the same, whatever the task; *e.g.*, working memory, default mode network, etc.).

What are the other types of general factors?

### *General factors are “teachable” or “unteachable”*

It is generally accepted that learning metacognitive knowledge and strategies is very effective from an academic point of view (De Boer et al., 2018). Therefore, some of this knowledge could be useful in any creative field. In other words, there would be “general knowledge” that can enhance creativity (e.g., the duration of creative learning). For example, students can be asked to regularly evaluate their creative performance and the strategies they use; in this manner, the teaching of problem-solving skills is complemented by the teaching of metacognitive skills. (“planning, information management strategies, comprehension monitoring, debugging strategies, and evaluation”; Hargrove & Nietfeld, 2015, p. 299). The impact of metacognitive and strategic knowledge would be far from negligible (Urban & Urban, 2023). This knowledge can nevertheless be taught. These metacognitive and strategic skills are not innate predispositions or acquired accidentally outside any external influence (such as family, friends, teachers, etc.). On the contrary, they are taught directly (by teachers) or indirectly (by imitation) by the environment in which individuals evolve.

In short, two kinds of general factors can have a significant positive impact on creativity: teachable factors (e.g., metacognitive knowledge, incentive environment) and non-teachable factors (e.g., faster neurons, naturally creative temperament, genetically transmitted creativity, etc.). Yet do these non-negligible, unteachable general factors exist? What do psychologists of creation think about it?

### *The minimalist hybrid models*

According to the “Componential Model of Creativity” (CMC; Amabile, 1983), “creative performance” depends essentially on three factors or “components”: “domain-relevant skills” (specific abilities), “creativity relevant skills” (general abilities), “task motivation” (specific motivation). In this model, only creativity-relevant skills are general factors. These general and creative skills are “appropriate cognitive style”, “implicit or explicit knowledge of heuristics for generating novel ideas” and “conducting work style”. The effectiveness of each of these three skills “depends on” “training”, “experience in idea generation” and “creative personality”.

“In an important way, creativity-relevant skills depend on personality characteristics related to self-discipline, ability to delay gratification, perseverance in the face of frustration, independence, and an absence of conformity in thinking or dependence on social approval (...) creativity-relevant skills also depend on training, through which they may be explicitly taught, or simply on experience with idea generation, through which an individual may devise his or her own strategies for creative thinking.” (Amabile, 1983, p. 365)

This theory does not suggest the existence of general factors that cannot be implicitly or explicitly taught. For instance, different models (family, culture, school, etc.) could indirectly teach (by imitation) “self-discipline”, “ability to delay gratification”, “perseverance in the face of frustration”, “independence”, “absence of conformity in thinking or dependence on social approval. In principle,

there is nothing to hinder the instruction of “his or her own strategies for creative thinking”. This is entirely consistent with one of Amabile's guiding ideas: the social space in which individuals work can have a strong impact on their internal motivation and, consequently, on their creative personality (Amabile, 1996, p. 17); the manager can modify the work atmosphere and thus increase the creativity of his or her staff (Amabile et al., 1996). No mention of genetic general factors or general faculties acquired accidentally outside any external influence. Personality seems to develop through social interaction. In CMC, there do not seem to be any unteachable general factors likely to have an impact on creativity.

Ultimately, this conception of creativity appears to be based on the assumption that all general factors can be taught. In such a theoretical framework, there is no room for non-teachable general factors (genetic predispositions for creativity, etc.). That is why we call this hypothesis the “minimal domain-general hypothesis”. In other words, according to this approach, creativity is “minimally” domain-general or the theory of creativity is “minimalist”. Indeed, in this perspective, there are only general and creative skills that anyone can acquire (provided they do not suffer from psychological or physiological disorders) if the educational or professional context so permits (educators who propose creative tasks, teachers or trainers who pass on creative strategies, managers who encourage and support innovation, etc.).

The Amusement Park Theoretical model of creativity (APT; Baer & Kaufman, 2017, 2005; Kaufman & Baer, 2004) also articulates general and specific factors. It even includes more or less specific factors. The latter, however, are not the focus of this study. This model contains three general factors likely to have an impact on creativity: “intelligence”, “motivation” and “environment”. “Intelligence” is nothing more here than Intellectual Quotient (IQ). According to the authors, the higher the IQ, the greater the creativity. “In general, there is a positive correlation between IQ scores and creative performance in virtually all domains” (Baer & Kaufman, 2005, p. 160). Creativity, nevertheless, stops increasing at an IQ of 120.

“Motivation” simply means the desire to do. “One must first have the desire to do something, regardless of what that something may be.” (Baer & Kaufman, 2005, p. 160). To put it another way, it's doing something rather than doing nothing that motivates some people. “Someone who lies on the couch all day and does not have the motivation to do anything will not be creative” (Baer & Kaufman, 2005, p. 160). Be that as it may, the authors recognize that motivation is a “complex phenomenon”: in their view, there are general motivations (*e.g.*, “motivations to excel, to be original, to perform, and simply to be creative that exist apart from specific interests in a given domain”) and specific motivations (*e.g.*, “person who is interested in writing short stories but not in writing poetry”). For them, motivation refers to a set of general and specific factors, rather than a single will to want.

As with Amabile (1983), general motivation can be influenced by the “environment”: “A person living or working in an environment that is supportive of original thought is more likely to be creative than a person in an environment that discourages such thought” (Baer & Kaufman, 2005, p. 160). In this

sense, the environment can be a general factor (the organization of the environment is always the same: open space, etc.) It invites human beings to be creative daily. Some environments, on the other hand, are not a general factor: they do not encourage human beings to be creative as a rule in their lives but to be creative in a particular area (“e.g., if one has an abundance of sports equipment but no musical instruments”). The environment is therefore also a complex phenomenon. Nonetheless, there are general environments that impact creativity in any domain, and which can be considered as general factors of creativity. Kaufman and Baer (2017) acknowledge the existence of “many other” non-negligible general factors (e.g., “openness to experience”), but none appear or are declared unteachable.

Like CMC, APC does not seem to include general non-teachable, and non-negligible factors. The students' or workers' environment can be transformed to foster and promote creativity. A general environment could therefore empower human beings to create (general motivation). One might think that “intelligence” is a general factor that cannot be taught in APC. However, the authors argue from the outset that this is only a necessary condition. “This research is not suggesting that someone must be smart to be creative, but rather that someone with a very low level of intelligence is very unlucky to demonstrate creativity” (Kaufman & Baer, 2004, p. 18). Intelligence therefore appears to be a negligible general factor in their approach: its impact on creativity remains fairly low in non-impaired individuals. In sum, CMC and APC are “minimalist” or “hybrid” hypotheses: they mention general and specific factors (hybrid hypothesis), but dismiss or minimize the impact of general, non-teachable factors (minimalist theory).

- (minimal domain-general hypothesis) Creativity is minimally domain-general if there are general factors that have a positive and non-negligible impact on creativity, and if all these factors can be taught directly (by teachers, parents, etc.) or indirectly (through peer imitation, workspace design, etc.).

#### *The maximalist domain-general models*

Hong and Milgram (2010), on the other hand, develop a hybrid model in which all general factors of creativity (“Creative Thinking abilities”) are non-negligible and non-teachable. Moreover, these factors have a very significant impact on creativity. In their view, their data suggest that these factors do not depend on the context in which human beings evolve. Only specific knowledge is susceptible to the fluctuations of life, influenced by factors such as family, social environment, culture, education, and so forth. This is why these authors wish to “open the door for a discussion of whether creative thinking ability – another type of general cognitive ability – is learned behavior or not” (Hong & Milgram, 2010, p. 284). In this respect, their conception of creativity is very different from those mentioned above. For them, “it seems reasonable to conclude that general creative thinking ability is not a domain - or context-bound ability” (Hong & Milgram, 2010, p. 284). So, their theory is clearly not “minimalist”. It is “maximalist” insofar as it admits the existence of non-teachable, non-negligible general factors



In Simonton's hierarchical model (2009), members of the same discipline (*e.g.*, physics, biology, arts, etc.) share the same dispositional (*e.g.*, the urge to become a biologist rather than an artist) and developmental (*e.g.*, “family and educational background”) characteristics. “For instance, creative writers tended to come from unhappy home environments, whereas better home conditions produced scientists and philosophers.” (Simonton, 2009, p. 446). These characteristics appear to be distributed along a *continuum*, from the most restrictive to the least restrictive. “The underlying assumption of the hierarchical arrangement is that domain-specific creativity varies from the logical, objective, formal, and conventional to the intuitive, subjective, emotional, and individualistic.” (Simonton, 2009, p. 449). In other words, the typical characteristics of a physicist are more “logical, objective, formal, and conventional” than those of a chemist, which is more “logical, objective, formal, and conventional” than those of a biologist, and so on.

Physicists have essentially the same characteristics. So, it is not these specific characteristics that explain the difference between a creative physicist and an ordinary physicist. “The most eminent members of the sample were no more or less typical of their domain than were their less eminent associates.” (Simonton, 2009, p. 448). For Simonton, the most creative in a domain tends to want to regress. All creators are “domain-regressive creators”: “those whose dispositional and developmental attributes would normally assign them to a lower level in the disciplinary hierarchy” (Simonton, 2009, 450). “As a case in point, creative contributors to a particular discipline tend to display traits that differentiate them from those who solely exhibit domain-specific expertise in same discipline”. (Simonton, 2008, p. 31).

In this approach, creators have to train just as hard as non-creative experts, but they have a mentality (a desire to regress) that the seconds do not have. That is why they use their expertise to create more often and with greater success. A creative physicist and a creative biologist do not have the same *specific* characteristics (dispositional and developmental), but they share the same *general* mindset (the domain-regressive desire). They want to be less constrained, and less conventional than those in their domain. And this mentality that can be observed in any domain is partly the result of genetic inheritance. “Environmental variables, including deliberate practice, explain most but not all of the variance in extraordinary accomplishments. At least for creators and leaders, nature as well as nurture underlies their attainments”. (Simonton, 2007, p. 84). Consequently, there is at least one general, non-teachable, and non-negligible factor in the hierarchical model: the genetic factor that drives the individual to be domain-regressive. So, this model is maximalist.

- (maximal domain-general hypothesis) Creativity is maximally domain-general if there are general factors that have a positive and non-negligible impact on creativity, and if at least one of these general factors is not teachable (*e.g.*, a genetic factor).

### *Educational consequences*

Why classify these different models into three categories (mechanist, minimalist, maximalist)? Researchers are not all saying the same thing when they say that “creativity is domain-general”. For some, this uniquely means that neural mechanisms are always the same, whatever the domain under consideration (mechanist domain-general hypothesis). For others, this means that there are general factors of creativity that are not negligible and that all these factors are teachable (minimalist domain-general hypothesis). For still others, it means that there are general factors of creativity that are not negligible and cannot be taught (maximalist domain-general hypothesis).

A theory of creativity can be mechanistic and minimalist (the performance of creative cognitive mechanisms depends solely on teachable factors such as improvisation training), mechanistic and maximalist (the same performance depends partially or totally on unteachable factors such as the genome), or purely mechanistic (the theory does not specify whether this performance depends on teachable or unteachable factors). A theory cannot be minimalist and maximalist.

These three distinctions (mechanist, minimalist, maximalist) have important consequences from an educational point of view. Indeed, the first leaves two burning questions unanswered: What should students be taught to develop their creativity? Is it relevant to identify students with high creative potential (whatever the domain) according to certain psychometric tests?

From a minimalist point of view, general creativity courses should be set up as a complement. An “optimal balance” should be found between “general creativity education” and “domain-specific creative learning” (Sawyer, 2015). This would involve teaching specific skills, but also general ergonomic skills (*e.g.*, the wise use of “makerspaces” including 3D printers; Pearson & Dubé, 2022) and general metacognitive skills (Lopata et al., 2022) likely to have a significant impact on creative performance. Moreover, “fostering individuals’ divergent thinking from the perspective of creative mindset intervention, apart from individuals’ metacognitive skills teaching (Hargrove and Nietfeld 2015), could be considered in the future” (Jia et al., 2022). In short, a minimalist approach implies the following practical advice in the field of education:

- (Educational recommendation 1) It is advisable to integrate general creativity training into school curricula or vocational training courses (*e.g.*, training in brainstorming or creativity self-assessment, inviting students to develop their creative personality, and rethinking work environments).

From a maximalist point of view, it could be interesting to select people with creative potential. “If creativity is a way of thinking, creativity might have a hierarchical structure, similar to the idea for *g* as a general intellectual ability” (Kim, 2011, p. 303). Some people are spontaneously inclined to create, some others less so or not at all. This is not to say that the creativity of all human beings cannot be enhanced. “The myth that people either have or do not have creativity, with no capacity for enhancement, is one of the most pervasive and stubborn myths surrounding creativity” (Plucker & Dow, 2004). It only means that certain non-teachable behaviors make it easier to enhance creativity. Therefore, psychometric

tests could be used to identify people with such a creative mindset and offer them more appropriate training. “Other words, before little *c* grows into Pro-*c* which usually takes years of professional training, students’ creative potential in a variety of areas should be carefully identified, valued and fulfilled in schools” (Qian et al., 2019, p. 9). Some envisage using these tests to select company staff (Cunningham & McGregor, 2016) or even vocational training students: “it might be advisable to use measures of both domain-general creative thinking, that is, ideational fluency abilities, and domain-specific creative thinking in architectural design in the process of selecting students for architecture” (Casakin et al., 2010, p. 33). Indeed, innovation seems increasingly essential to maintain or acquire market share in the face of competition. “The need for manual labour in predictable and repetitive work is declining, while the demand is soaring for expertise in creative tasks, problem-solving and other social-cognitive avenues of soft-skills” (Baten et al., 2020, p. 1). It could make economic sense for a nation to identify those individuals most likely to be creative, and ensure that their gift is not wasted.

“It is clear that the relevance and importance of the TTCT, and other domain general creativity measures, in the 21st century will continue to be useful in the identification of highly creative students and in the nurture and development of creative thinking skills.” (Kim, 2011, p. 306)

From a maximalist point of view, the following practical advice is therefore conceivable:

- (Educational recommendation 2) It is advisable to select students or employees with a view to offering them educational or career paths more suited to their general creative profile (*e.g.*, creative mindset in all domains).

### *Domain-general evidence*

What is the evidence in favor of the general domain hypothesis? People who are creative in one area tend to be creative in many others. At least, that is what the results of numerous studies would show (as we shall see, data from 73 empirical studies seem to suggest that this is the case; Figure 2): in these studies, some participants give the impression of being creative in several areas. Indeed, the domain-general hypothesis only makes sense if correlations can be observed between different types of creative tasks. “The key evidence for this position is that measures of creativity within particular domains (usually creative performance and activity checklists) show significant intercorrelations” (An & Runco, 2016, p. 523). At first glance, the results seem mixed. Some studies show correlations, while others do not. Yet studies that do not show correlations may have an important methodological weakness: they would use only one creative task per domain (Chen et al., 2006). As Qian et al. (2019, p. 2) point out, creative performance “based on a single task is not really generalizable because of task sampling variation. The same principle applies to creativity self-assessment as well, and a latent psychological construct is rarely measured through one single survey item.” Moreover, certain correlations appear even in studies that reject the domain-general hypothesis (Qian et al., 2019). At first

glance, it does not seem possible to rule out this possibility: “this absence of evidence for domain-generalness might be due to the statistical analyses used” (Said-Metwaly et al., 2021, p. 288).

However, the vast majority of the studies does not measure participants' creative performance. Instead, they use various self-reports (e.g., Karwowski et al., 2019; Plucker, 1999) and this observation is consistent with previous works (Snyder et al., 2019; Forgeard & Kaufman, 2016): over the past 40 years, research on creativity has increasingly focused on self-reports and less on creative performance tasks. Alves-Oliveira et al. (2021) show in their meta-analysis that only 8% of creative training programs evaluate students' creative performances. In other words, these studies do not validate the domain-general hypothesis. On the contrary, they postulate its validity. There are many creative activity books on the market in which the reader is only invited to reproduce models. A person may believe themselves to be imaginative or open-minded, when in fact they are merely reproducing certain stereotypes in their everyday life (wearing "artistic" clothes, etc.). This is why it is necessary to control the creativity of participants. A study using only self-reports does not necessarily show that some participants have a creative mind. It may simply show that these participants present themselves as creative people. In their meta-analysis, Haas et al. (2018) found little or no correlation between creative performance and how people perceive their creativity. Their research highlights “the need for researchers to distinguish between different instruments – not the least between self-report scales and more objective test procedures” (Haas et al., 2018, p. 1). For this reason, this literature review excludes all studies using only self-reports. It only includes studies that can potentially prove the general domain hypothesis. In other words, it only includes studies in which there are at least two creativity tasks (e.g., participants must solve a research problem or create a plastic work) in two different domains.

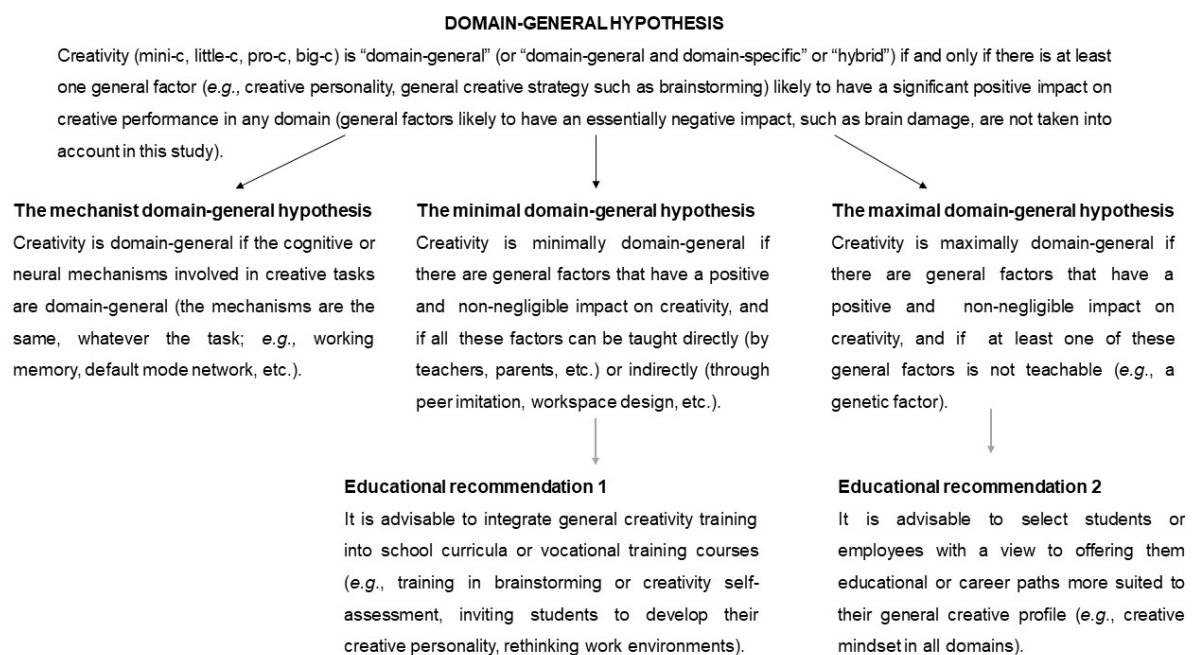


Figure 1: A synthetic representation of the domain-general hypothesis, its variants (mechanistic, minimalist, maximalist) and its educational challenges (educational recommendations 1 and 2). Arrows mean "leads to" and not "implies". This figure brings

together the five main definitions that we have just formulated and that will guide our analysis (see last column of table 1). Minimalists tend to emphasize the possibility of teaching general creativity and maximalists, the possibility of selecting potentially creative individuals. One educational recommendation does not necessarily exclude another. The mechanistic hypothesis is compatible with both minimalist and maximalist approaches (even if this is not systematically specified). Minimalism and maximalism are not compatible with each other (even if their recommendations are).

### **The present study**

The purpose of this systematic literature review is to assess the validity of the domain-general hypothesis (Figure 1). Are some people more creative (mini-c, little-c, pro-c, big-c) than the average, whatever the domain? In sum, this work raises the following research question: Are there any studies that explicitly defend the domain-general hypothesis and show that some individuals can succeed in creative performance tasks (mini-c, little-c, pro-c, big-c) in several different domains? If these individuals exist then:

- Condition 1: They should be able to successfully complete at least two creative performance tasks (mini-c, little-c, pro-c or big-c) in at least two different domains.
- Condition 2: Their prior knowledge (in at least these two different domains) should be controlled. In other words, their creative performance cannot be explained by specific prior knowledge. For example, they may have specific knowledge of mathematics (*e.g.*, multiplication tables) and literature (*e.g.*, Greek mythology). It may be for this reason that they succeed in the creative tasks in mathematics as well as in literature; it is therefore important to ensure that this is not the case, by first assessing their specific knowledge of mathematics and literature.
- Condition 3: They should be able to perform these tasks in real-life situations (*e.g.*, professional setting). Results obtained in artificial situations (*e.g.*, solving problems that do not exist in any social sphere outside the school or laboratory) do not show that participants are actually creative. This data just shows that these participants can perform artificial creative tasks. A creative person should be able to succeed in realistic creative tasks (*e.g.*, at work, at home, in sports, arts, etc.). Their performance should not be inherently restricted to experimental tasks.

These last three conditions structure this literature review. The domain-general hypothesis could be supported if there are empirical results in which the participants fulfill these three conditions. It will then be possible to determine whether the practical recommendations of minimalist (educational recommendation 1) and maximalist (educational recommendation 2) theories can be formulated. As a reminder, these recommendations are as follows: it is advisable to integrate general creativity training into school curricula or vocational training courses (educational recommendation 1); it is advisable to select students or employees to offer them educational or career paths more suited to their general creative profile (educational recommendation 2).

## Method

This systematic literature review adopts the PRISMA model (Moher et al., 2009). During the first stage, five databases from 1973 to 2023 were examined: *Medline*, *PsycINFO*, *PsycArticles*, *Psychology and Behavioral Sciences Collection*, and *ERIC* (search engine: *EBSCOhost*). The keywords were *creativ\**, *domain-general\**, *generality\** and *cross-domain\** in order to identify all the articles likely to explicitly defend the “domain-general” hypothesis. Indeed, the words “creative” and especially “creativity” are always the most employed (Snyder et al., 2019); moreover, the expressions “cross-domain”, “generality” and “domain-general” are traditionally used to address the opposition between “domain-general” and “domain-specific” skills (e.g., Teng et al., 2022; Scotney et al., 2019; Plucker, 1999).

Three combinations of two keywords were searched by *EBSCOhost* in the title, abstract and subject-terms: *creativ\* & domain-general\**; *creativ\* & generality\**; *creativ\* & cross-domain\**. A total of 247 documents were identified in this way, then 76 duplicates (or corrections of published articles) were removed. Only articles in English have been retained.

### Exclusion criteria

In the second stage, all the abstracts were examined in detail ( $n = 171$ ) by one person. Let us remember that this systematic review aimed to evaluate the domain-general hypothesis. This means that there must be participants who can complete creative performance tasks in different domains (at least two scores of creative performance in two domains must be available). This criterion excludes non-empirical or non-quantitative studies: all qualitative studies (e.g., Harrison, 2016) and all non-empirical studies (meta-analyses, literature reviews, theoretical or methodological articles: e.g., Chen et al., 2020; Plucker, 1998). It also excludes studies in which participants do not obtain at least two creative performance scores in two distinct domains: studies where there are only “self-report” creative tasks (e.g., Qian et al., 2019) or only one performance creative task (e.g., Furley & Memmert, 2015) or only one domain (e.g. Monechi et al., 2019). Indeed, some abstracts were sufficiently precise in their content. If they were not (e.g., it was impossible to determine whether there were several domains or creative performance tasks without reading the article), the article was not excluded because it did not meet the *exclusion* criteria (Figure 2). A divergence task is systematically considered a creative task. (“The terms creativity and divergent thinking may even be used rather interchangeably”; p. 99) A fluid intelligence task (e.g., an inductive reasoning task) is not considered a creative task (unless otherwise specified by the authors). Even if the aim is not to evaluate the domain-specific hypothesis, studies that meet our criteria and criticize the domain-general hypothesis are not excluded, to avoid any selection bias (e.g., fewer references to be analyzed in the fourth step).

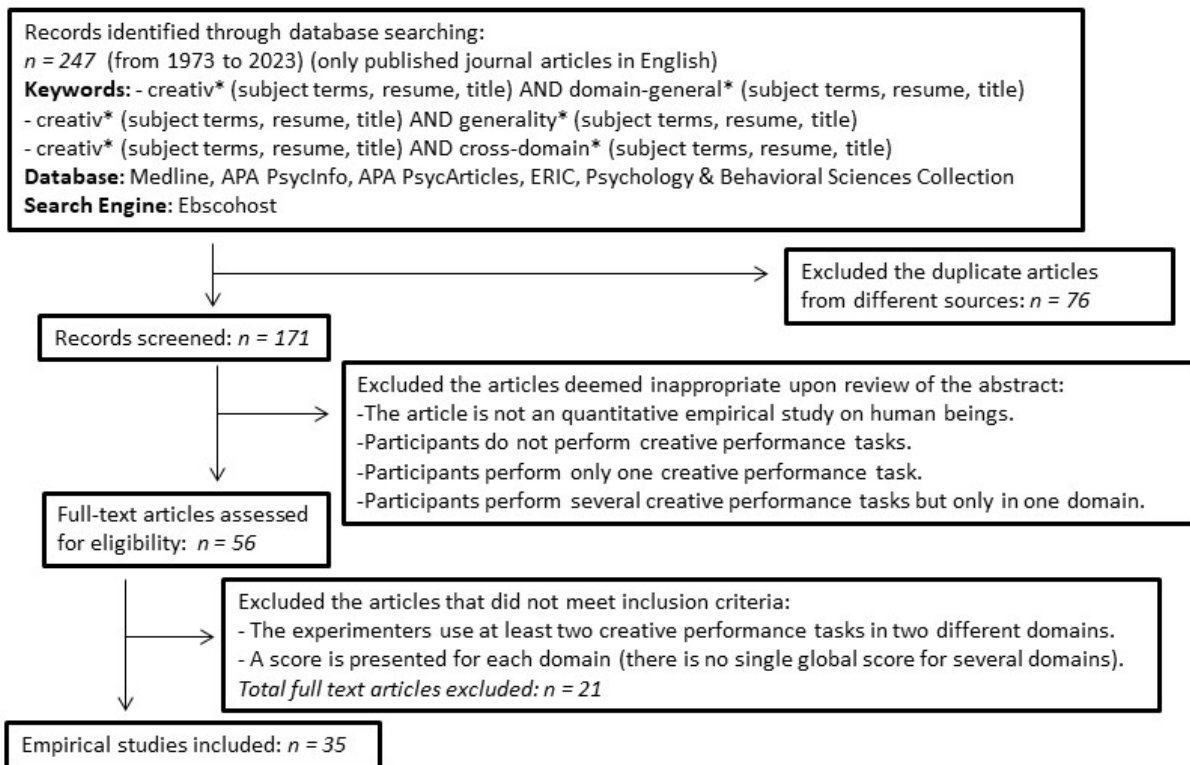


Figure 2 : Flow chart of search and screening process.

### Inclusion criteria

In the third stage, non-excluded articles are thoroughly reviewed ( $n = 56$ ) by the same person. A study is included in the review if participants obtain at least two creative performance *scores* in two distinct domains. Some creative performance tasks assign several scores to each participant. For example, participants take a verbal divergent task and obtain three scores for this task (*e.g.*, Saad et al., 2013): one score for their “fluency”, one score for their “originality” and one score for their “flexibility”. In this particular situation, there are three scores for a single creative performance task. We therefore consider in this case that there are three creative performance tasks (one task per score) and only one domain (the verbal domain). In this way, a total of 35 studies were included.

### Backward/forward search

To conclude, a backward search (an analysis of all the references mentioned in these 35 articles) and a forward search (an analysis of all studies mentioning these 35 articles) were carried out (Figure 3). 1334 references were examined during this fourth stage. We used strictly the same selection criteria as before. In the end, only one new study was identified (confirming the scope of our criteria).

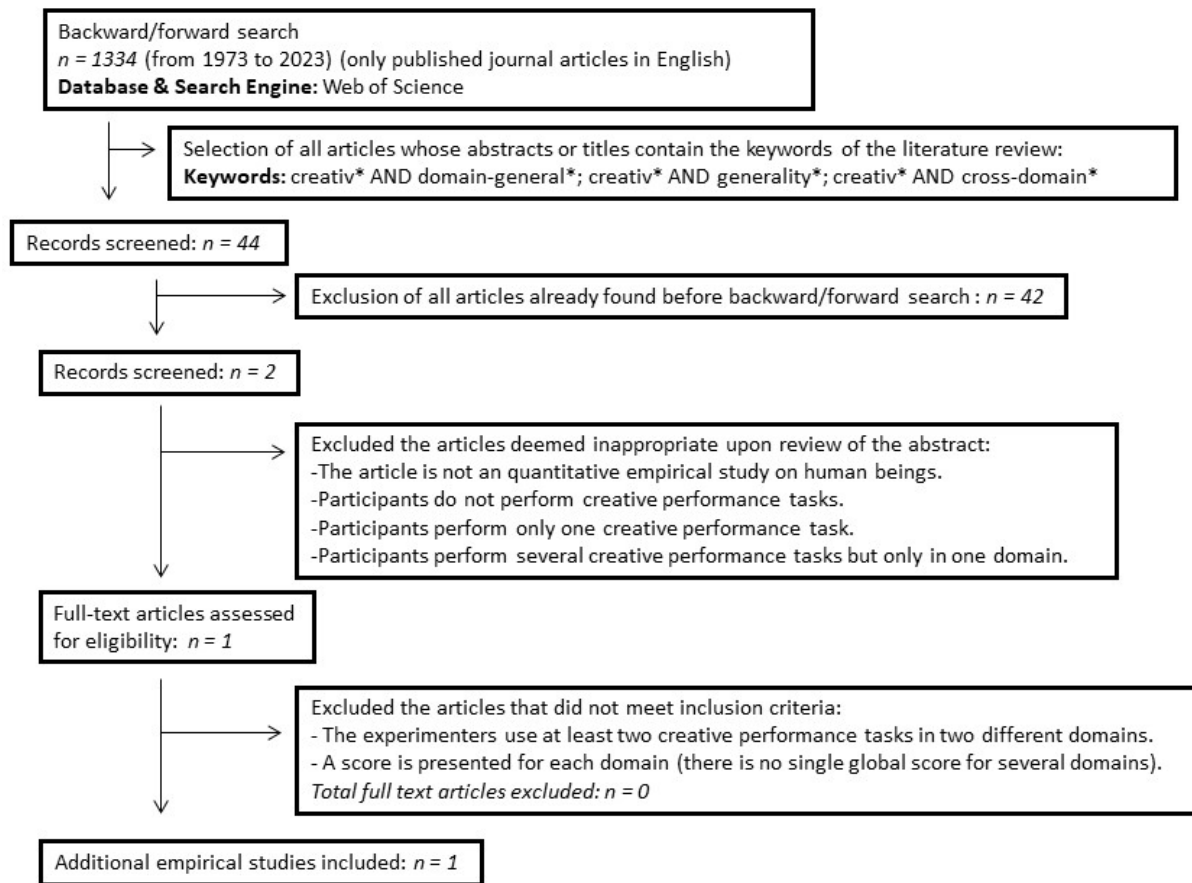


Figure 3: backward/forward search

### Selected articles

36 articles were finally selected (Table 1) with a total number of participants equal to 8,496.

## Results

29 of these 36 articles defend the domain-general hypotheses: Four studies are “mechanist” (two of them are both mechanical and minimalist); 17 are “minimalist”; Six are “maximalist”; Four are unspecified (“ø”). In other words, for the majority of authors, general factors are all teachable. This is an important point of convergence between studies that defend and those that reject the general domain hypothesis: for all these studies, creativity is never an innate faculty (even in part); its degree depends solely on the quality of the school environment, family, etc. Thus, the main disagreement lies in the existence and importance of general factors. For instance, should students be taught general creative strategies or more specific ones (characteristic of a discipline or type of task)?

The other articles (n = 7) do not support the domain-general hypothesis and they are referred to as “only specific factors” (see the last column of Table 1). It should be remembered that they were selected to avoid any potential selection bias (e.g., relevant references absent from backward/forward search). Studies that do not support the domain-general hypothesis are not the subject of this study.



Table 1 lists the observations made for each article selected. Five main results appear in this table for studies with a domain-general approach (n = 29):

- Column 1: Participants are always students in these 29 studies in favor of the general domain hypothesis: in 18 studies, the participants were undergraduate students; in 11 studies, the participants were K-12 students.
- Column 2: Prior knowledge is hardly ever controlled. 28 Studies measure participants' creative performance, but they never measure their prior knowledge (in particular, knowledge that could help them perform). Only Fink et al. (2020) control prior knowledge.
- Column 3: In these 29 studies, participants complete at least two creative performance tasks in two domains. For example, some students succeed in creative poetry and geometry tests.
- Column 4: Creative performance tasks are never designed by experts or teachers in the domain in these 29 studies. For instance, the creative story-writing tasks proposed to participants were not designed by professional writers or even literature teachers. Creative tasks are designed solely by the experimenters. Only May et al. (2020) use *one* task (“performance task”) designed and assessed by a teacher (it is not the case for their other two creative performance tasks).
- Column 5: From a theoretical point of view, these 29 studies only explore “little-c” creativity. Indeed, participants are always students. These studies may defend a mechanistic, minimalist or maximalist approach. Only four of them do not specify their position on this point ( $\emptyset$ ). For them, it is impossible to know whether creativity is domain-general because the underlying cognitive processes are domain-general (mechanistic hypothesis), or whether creativity is totally teachable (minimalist hypothesis) or only partially teachable (maximalist hypothesis).

How do these five results relate to the conditions structuring this literature review? As already explained, *three* conditions structure this literature review. More precisely, to validate the general domain hypothesis: participant must be able to complete at least two creative performance tasks in at least two different domains (condition 1); their prior knowledge should be controlled (condition 2); they should be able to perform these tasks in real life situations (condition 3). In sum:

- Column 3 shows that the 29 studies in favor of the general domain hypothesis meet condition 1.
- Column 2 shows that 28 of these 29 studies do not meet condition 2.
- Column 4 shows that these 28 use only *artificial* performance creative tasks and do not meet condition 3 inside the school context.
- Column 5 shows these 29 studies never take place in a professional environment and do not meet condition 3 outside the school context.

How to interpret these results?

Table 1: The control of prior knowledge and the type of creative performance tasks or tests used in the empirical studies (total number of participants: 8,496)

Articles ( $N = 36$ )	Control of prior knowledge	Creative performance tasks or tests	Type of tasks or tests	Theoretical conception
Agnoli et al., 2016 University students $n > 300$ (♂ ♀); Italy $\alpha = \emptyset$	No control	Remote Associates Test (RAT)	Artificial	Little-c
		Insight problems	Artificial	Minimalist
		Title task	Artificial	
		Figures Task	Artificial	
		Realistic Problems	Artificial	
		Judgement task	Artificial	
An et al., 2018 <i>Study 1</i> Undergraduate students $n = 80$ (29♀); South Korea $\alpha = 23$	No control	Idea Generation Task	Artificial	Little-c
		Remote Associate Tests (RAT)	Artificial	$\emptyset$
<i>Study 3a</i> Business school students $n = 94$ (47♀); South Korea $\alpha = 20$	No control	Design Problem	Artificial	
		Brand-naming Problem	Artificial	
<i>Study 3b</i> Business school students	No control	Recycling Problem	Artificial	
		Brand-naming Problem	Artificial	

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n = 79 (31♀); South Korea				
$\alpha = 22$				
Baer, 1991	No control	The single-item verbal-fluency task	Artificial	Little-c
8 <sup>th</sup> -grade students		Poetry-Writing Test	Artificial	Only specific
n = 50 (25♀); USA		Story-Writing Test	Artificial	factors
$\alpha = \emptyset$		Word-Problem-Creating Test	Artificial	
		Equation-creating test	Artificial	
Baer, 1994	No control	The single-item verbal-fluency task	Artificial	Little-c
8 <sup>th</sup> -grade students		Poetry-Writing Test	Artificial	Only specific
n = 128 (66♀); USA		Story-Writing Test	Artificial	factors
$\alpha = \emptyset$		Word-Problem-Creating Test	Artificial	
		Equation-creating test	Artificial	
Barbot et al., 2016	No control	Convergent-Integrative Tasks: <i>Abstract Stimuli,</i>	Artificial	Little-c
School Students		<i>Concrete Stimuli, Story Titles, Story Characters</i>		Maximalist
n = 482 (248♀); France		Divergent Exploratory: <i>Abstract Stimulus, Concrete</i>	Artificial	
$\alpha = 11.7$		<i>Stimulus, Story Endings, Story Beginnings</i>		
Beaty et al., 2013	No control	Improvisation	Artificial	Little-c
University of music students		Divergent thinking task	Artificial	Maximalist

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$n = 10$ (0 ♀); USA $\alpha = \emptyset$				
Bernal et al., 2017 Middle school students $n = 133$ (75♀); Spain $\alpha = 14.6$	Control	Figurative Torrance Thinking Creative Test Creative Scientific Thinking Test	Artificial Artificial	Little-c Only specific factors
Benedek et al., 2014 University of music students $n = 99$ (47♀); Austria $\alpha = 24.8$	No control	Two alternate uses tasks Two instances tasks Picture completion task	Artificial Artificial Artificial	Little-c Minimalist
Casakin et al., 2010 University students $n = 111$ (58♀); Israel $\alpha = 25.97$	No control	Tel Aviv Creativity Test The Real-Life Problem Solving: Architecture (RLPS: A)	Artificial $\emptyset$	Little-c Maximalist
Chen et al., 2023 University students $n = 31$ (20♀); USA $\alpha = 19.30$	No control	Uses Generation Task – creative version (UGT) Metaphor Production Task (MPT)	Artificial Artificial	Little-c Mechanist

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Chen et al., 2006	No control	Poetry task	Artificial	Little-c
Undergraduate students		Story task	Artificial	Minimalist
$n = 158$ (112♀); USA		Title-writing tasks	Artificial	
$\alpha = 21.66$		Geometric Drawing task	Artificial	
		Non geometric drawing task	Artificial	
		Design task	Artificial	
		Cutting Rectangles Task	Artificial	
		Nine-Dot Areas Task	Artificial	
Conti et al., 1996	No control	Study 1: Writing tasks: <i>Boat picture, Desk Picture, Blank Box, Story Mean</i>	Artificial	Little-c
Psychology students;		Study 2: Artistic tasks: <i>Collage, Drawing, Painting, Art Mean</i>	Artificial	Minimalist
$\alpha = \emptyset$ ; USA		Study 3: Psychological story task	Artificial	
Study 1: $n = 82$ (52 ♀ )				
Study 2: $n = 87$ (57♀)				
Study 3: $n = 75$ (56♀)				

Dollinger et al., 2004 University students $n = 151$ (92♀); USA $\alpha = 22$	No control	Test for Creative Thinking - Drawing Production (TCT-DP) Stories Photos	Artificial Artificial Artificial	Little-c $\emptyset$
Fink et al., 2020 4 <sup>th</sup> -grade students $n = 77$ (41♀); USA $\alpha = 9.39$	Control	Verbal tasks: <i>Dice-Words, Mysterious Bag, Lonely Island, Visiting Aliens, Bathtub (verbal version), Initial Letters</i> Figural tasks: <i>Living Shapes, Divided Drawing, Lonely Island (figural version), Dressing Up Friends, Bathtub (figural version), We Draw A Picture</i> Verbal divergent task Figural divergent task Story completion Painting picture	Artificial Artificial Artificial Artificial Artificial Artificial	Little-c Minimalist
Han & Marvin, 2002 2 <sup>nd</sup> -grade students $n = 109$ (56♀); USA $\alpha = 7.01-8.09$	No control	Wallach-Kogan Creativity Test. Real- World Divergent Thinking Test.	Artificial Artificial	Little-c Only specific factors

Hong et al., 2013 10 <sup>th</sup> -grade students <i>n</i> = 478 (244♀); China $\alpha = \emptyset$	No control	Thinking and Imagination Thinking and Imagination: Problem Solving (TIPS)	Artificial Artificial	Little-c Maximalist
Hong & Milgram, 2010 High school and university students <i>n</i> = 130 (63♀); Israel $\alpha = 25.5$ (university students) $\alpha = \emptyset$ (high school students)	No control	Tel Aviv Creativity Test (TACT) Ariel Real-Life Problem Solving (ARLPS)	Artificial Artificial	Little-c Maximalist
Howieson, 1981 7 <sup>th</sup> students and the same students 10 years later <i>n</i> = 130 (67♀); Australia $\alpha = 22$	No control	Torrance Test of Creative Thinking (TTCT) – Fluency TTCT – Originality TTCT – Verbal TTCT – Non Verbal Wallach & Kogan Test	Artificial Artificial Artificial Artificial	Little-c Minimalist
Huang et al., 2017 6 <sup>th</sup> -grade students <i>n</i> = 187 (94♀); Taiwan $\alpha = 12.28$	Control	Scientific creativity test Mathematical creativity test Newly creativity test	Artificial Artificial Artificial	Little-c Only specific factors

Huang & Wang, 2019 11 <sup>th</sup> -grade students <i>n</i> = 60 (28♀); Taiwan $\alpha$ = 14.2	No control	Scientific Creativity Test Creative Scientific Ability Test (C-SAT) Domain-General Creativity Test (DGCT)	Artificial Artificial Artificial	Little-c Minimalist
Joy, 2008 Undergraduate students <i>n</i> = 68 (51♀); USA $\alpha$ = 14.2	No control	Creative Writing (Poetry) Measure The House-Tree-Person test (H-T-P)	Artificial Artificial	Little-c Maximalist
Karwowski et al., 2020 1 <sup>st</sup> -grade and 6 <sup>th</sup> -grade students <i>n</i> = 2,372 (1,243♀); Poland $\alpha$ = $\emptyset$	No control	Creativity and Learning in School Achievement Test (CLISAT) Divergent Thinking tests	Artificial Artificial	Little-c $\emptyset$
Kline & Cooper, 1986 Undergraduate students <i>n</i> = 173 (96♀); England $\alpha$ = 20	No control	Flexibility of closure Spontaneous flexibility Ideational fluency World fluency Originality	Artificial Artificial Artificial Artificial Artificial	Little-c $\emptyset$



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Larraz Rábanos et al., 2021	No control	Narrative Creativity	Artificial	Little-c
University Students		Graphic Creativity	Artificial	Minimalist
$n = 135$ (104♀); Spain		Overall Creativity	Artificial	
$\alpha = 18.19$				
Lee et al., 2012	No control		Artificial	Little-c
University students			Artificial	Mechanist
$n = 135$ (104♀); USA				
$\alpha = 20.27$				
May, 2020	No control	Abbreviated Torrance Test for Adults (ATTA)	Artificial	Little-c
University students		Flexible Thinking Test (FTT)	Artificial	Minimalist
$n = 240$ (179♀); England		Performance task	Academic	
$\alpha = 19$				
Meier et al., 2023	Control	Mathematical creativity task	Artificial	Little-c
University students and a few faculty members. Austria, Germany, and Switzerland.		Domain-general creativity	Artificial	Only specific factors
$n = 224$ (108♀)				
$\alpha = 27-28.47$				

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Mohamed et al., 2012 1 <sup>st</sup> and 2 <sup>nd</sup> grade students <i>n</i> = 135(♂ ♀); USA $\alpha = \emptyset$	No control	Test for Creative Thinking - Drawing Production (TCT-DP)	Artificial	Little-c Minimalist
		DISCOVER - Spatial Artistic	Artificial	
		DISCOVER - Oral Linguistic	Artificial	
		DISCOVER – Logical Mathematical	Artificial	
Mourgues et al., 2016 7 <sup>th</sup> -grade students <i>n</i> = 315 (146♀); England $\alpha = 12.62$	No control	Conversation task	Artificial	Little-c Minimalist
		Figurative language task	Artificial	
		Cartoon numbers task	Artificial	
		Book covers task	Artificial	
		Multiple uses task	Artificial	
Palmiero et al., 2019 School students <i>n</i> = 58 (33♀) $\alpha = 7.92-8.4$	Control	The Visual Divergent Thinking Task	Artificial	Little-c Only specific factors
		The Motor-Form Divergent Thinking Task	Artificial	
Przysinda et al., 2017 University students and Music school students <i>n</i> = 36 (12♀); USA $\alpha = 20.23$	No control	EEG: harmonic expectation task	Artificial	Little-c Minimalist
		Torrance Test of Creative Thinking (TTCT)	Artificial	

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Schoevers et al., 2018 4 <sup>th</sup> -grade students <i>n</i> = 342 (171♀); Netherlands $\alpha$ = 9.68	No control	Mathematical Creativity Test (MCT) Test for Creative Thinking - Drawing Production (TCT-DP) Torrance Test of Creative Thinking (TTCT)	Artificial Artificial Artificial	Little-c Mechanist Minimalist
Sowden et al., 2015 Elementary students United Kingdom Exp.1: <i>n</i> = 27 (10♀); $\alpha$ = 9.00 Exp.2: <i>n</i> = 34 (ø♀); $\alpha$ = 10-11	No control	Instances Task Product Design Task The Incomplete Figures Tasks Three verbal and acting games	Artificial Artificial Artificial Artificial	Little-c Mechanist Minimalist
Stolte et al., 2020 4 <sup>th</sup> -grade students <i>n</i> = 278 (139♀); Netherlands $\alpha$ = 9.71	No control	Mathematical Creativity Test (MCT) Test for Creativity Thinking Drawing Production (TCT-DP)	Artificial Artificial	Little-c Minimalist
Teng et al., 2022 Undergraduate students <i>n</i> = 71(62♀); China $\alpha$ = 21.20 or 21.86	No control	Alternative Uses Task (AUT) Figural Torrance Test of Creative Thinking (TTCT) Product Design Task Book Cover Design Task	Artificial Artificial Artificial Artificial	Little-c Minimalist

Tong et al., 2022	No control	Unusual Uses Task (UUT)	Artificial	Little-c
University students		Figural Torrance Test of Creative Thinking (TTCT)	Artificial	Minimalist
n = 532 (310♀); China		Verbal TTCT	Artificial	
$\alpha_{\varphi} = 19.49; \alpha_{\sigma} = 19.25$				

*Note:* The second column indicates whether the studies try to control for prior knowledge ("control" or "no control"). The third column gathers all creative performance tasks of each study. The fourth column specifies the type of these tasks: a task or a test is "artificial" if it is designed or evaluated by individuals who are neither domain experts nor domain teachers (e.g., experimenters, evaluator participants). The last column indicates the type of creation studied (mini-c, little-c, pro-c, big-c) and how the general factors are conceptualized (specific, mechanist, minimalist, maximalist). Studies that reject the existence of any general factors are qualified by the expression "only specific factors". The first column indicates the name of the study, the type of participants (e.g., renowned experts, professionals, university students), the number of participants (n), the number of women or girls (♀), the country where participants lived, and the average age of participants ( $\alpha$ ). Sometimes, in some articles, some information is missing ( $\emptyset$ ). In the last column, any note  $\emptyset$  means that the article defends the general hypothesis, but that there is no indication of its overall orientation (mechanist, minimalist, maximalist).

## Discussion

There are situations in which some participants complete at least two creative performance tasks in two different domains, as shown in the third column of Table 1. At first glance, this result validates the general domain hypothesis (condition 1 is met). This literature review is the first to systematically highlight two fundamental limitations of this result. Firstly, this result is only obtained when participants' prior knowledge is not controlled: their success could be entirely explained by the use of specific knowledge (condition 2 is not met). Secondly, this result is only obtained when the creative performance tasks are artificial: their success would tell us nothing about creativity in real-life situations (condition 3 is not met). Many previous meta-analyses (Acar et al., 2024; Bicer et al., 2020; Chen et al., 2020; Gadja et al., 2016; Karwowski & Lebuda, 2016) and literature reviews (Beatty 2015; Kim, 2011; Loui, 2018; Pasarín-Lavín, 2023; Zhang et al., 2022) did not consider these three decisive conditions together. Perhaps this is why they did not reach the same conclusions as this review (they defended the domain-general hypothesis). In addition, as we will see, some studies confuse the generality of the function with the generality of its functioning. This can lead to a theoretically illegitimate justification of the domain-general assumption. In the current state of knowledge, it is impossible to validate Educational recommendation 1 (it is advisable to integrate general creativity training into school curricula or vocational training courses) or 2 (it is advisable to select students or employees with a view to offering them educational or career paths more suited to their general creative profile).

### Is Prior knowledge controlled? (condition 2)

The experimenters never control the participants' prior knowledge: they do not attempt to identify specific knowledge that is useful for completing the creative performance tasks they propose; they never assess whether participants master this specific knowledge (this result is in line with previous findings: Long & Wang, 2022, p. 1432). Therefore, participants may already have the specific knowledge in long-term memory that allows them to succeed in a given task. For instance, experimenters ask participants to invent alternative uses for familiar objects (*e.g.*, *UGT-creative condition*; Chen et al., 2023): a new way to use a pen, etc. It is possible to explain participants' creative performances by their school or family culture. Some read fantasy stories. Others attend contemporary art museums. Some have learned very explicitly in school-specific creative strategies (Alves-Oliveira et al., 2021): decomposing and recomposing an image in art to invent new objects, testing different values to solve a research problem in mathematics, combining several types of narrative structures when writing a story or poetry, multiplying points of view on an event in history, etc. All of this domain-specific knowledge is potentially relevant to inventing unconventional uses of familiar objects, renaming books, inventing stories or poems, etc. Creative performance tasks may only measure the adequacy of participants' knowledge to perform a particular task.

Indeed, every human being has the capacity to memorize a substantial amount of specific knowledge. Thus, they can perform tasks in many areas. This does not mean that his or her creativity is

domain-general: being creative in *several* domains does not mean being creative in *any* domain. So, it is not enough to propose tasks in different domains to the participants. Ensuring that all of them have an identical level of specific knowledge in each tested domain, including a comparable breadth of vocabulary for instance, is imperative. This is the only way to show that their specific knowledge is not the main factor of performance. This is the only way to show that their creativity is not simply and essentially based on the quantity and quality of specific knowledge stored in their long-term memory (domain-specific hypothesis). All creative performance requires certain knowledge: words to associate, visual images to recombine, search strategies, etc. No one disputes this. Hence, it is crucial to demonstrate that creative performance is not primarily accounted for by the possession of this knowledge. Especially when some empirical studies suggest that creative performance depends on the greater or lesser memorization of specific knowledge.

As an illustration, dance instruction increases success in motor-divergent thinking tasks (Palmiero et al., 2019). “When students possess more knowledge in science or mathematics, they perform better on scientific and mathematical creativity tests” (Huang et al., 2017). Scientific and artistic creativity vary according to specific visualization abilities: painters know how to represent concrete objects while scientists know how to represent abstract spaces (Kozhevnikov et al., 2013). Creative solving problems in ordinary life (my employer is asking me to solve this unprecedented problem., etc.) depends on the type of problem considered (Reiter-Palmon & Illies, 2004). Specific training impacts academic creative performance and “divergent thinking” tasks (Fink et al., 2019). Prior domain-specific knowledge modulates electrophysiological responses to novel metaphors and impacts on creative language comprehension (Jończyk et al., 2019). A meta-analysis suggests that domain-specific creativity training is more effective than domain-general creativity training (Scott et al., 2004). It is even theoretically possible to define creative personality "traits" by a set of specific skills and thus propose a "domain-specific specification" of a domain-general theory (Schindler & Rott, 2017).

The problem is therefore not only "the absence of good evidence in favor of domain-generality" as argued by Chen et al. (2006, p. 181) – see also Silvia et al. (2009, p. 141). The domain-general hypothesis suffers from all those studies in which teaching specific knowledge impacts divergent thinking or domain-general skills. Their results strongly suggest that tests of “divergent thinking” and “domain-general abilities” or traits are not domain-general. That is why the control of prior knowledge should not be an option but a necessity when the goal is to fully or even partially support the domain-general hypothesis.

Chen et al. (2006) show that there is only a weak correlation between the Verbal Scholastic Assessment Test (SAT-verbal score) and verbal creativity tasks (chair design, poem writing, story writing). This result apparently contradicts those we have just mentioned: specific knowledge (measured by SAT) does not impact creativity abilities (measured by verbal creativity tasks). How can such a factual contradiction be explained? Firstly, the correlation is weak. Secondly, the authors use SAT data to measure academic knowledge and it is possible that this data is not relevant: the knowledge required

to pass the SAT may not be the same as the knowledge required to write a poem, design a chair or write a story. Studies generally observe a “mediocre” correlation between academic achievement and creative performance (Karwowski et al., 2020, p. 13), but academic achievement in a discipline (math, language, etc.) is not a sufficiently reliable measure of a specific knowledge. Prior knowledge (vocabulary, strategies, etc.) that may contribute to the success of a particular creative task should be clearly identified. It would be necessary to ensure that some participants can complete the task without this knowledge (whether the objective is to validate the domain-general hypothesis).

Howieson, 1981, Dollinger et al., 2004, Mohamed et al., 2012, Shoevers et al. (2018), Stolte et al. (2020) and Teng et al. (2022) measure “Domain-General Creativity” using tools that are widely used in creativity research: the Alternative Uses Task (AUT); Test for Creative Thinking - Drawing Production (TCT-DP); or the Torrance Test of Creative Thinking (TTCT). The problem is that there is no evidence that these psychometric tools measure “Domain-General” creativity. To show this, the prior knowledge of the participants would have to be accurately controlled. What knowledge could the participants use to pass each task of each tool? Do they already have this knowledge? These supposedly “domain-general” tests could be completed only with different specific knowledge. This problem cannot be ignored when research shows that teaching specific knowledge increases success on these “domain-general” tests (see above). Teng et al. (2022, p. 62) even note that “group (design [training] vs. non-design [training]) first influenced visual divergent thinking and then influenced design originality and amenity, which in turn influenced design overall evaluation”. Thus, it may be that students in design training learned some specific knowledge (in the “visual” domain) that was useful for passing all the divergent thinking tests. A recent meta-analysis by Said-Metwaly et al. (2021, pp. 290-291) illustrates that changing the domain of a divergent thinking task affects performance.

Huang and Wang (2019) observe a weak correlation between the “Scientific Performance Test” (SPT) and the “Creative Scientific Ability Test” (CSA-T), but they also observe a medium correlation between SPT and “Scientific creativity test” or between SPT and “Domain-General Creativity Test” (DGCT). They interpret these conflicting results by the type of evaluation used (summative for SPT and formative for CSA-T). These inconsistent results do not validate the domain-specific hypothesis, but they illustrate once again how essential it is to control prior knowledge: even the type of evaluation could produce opposite results.

Hong and Milgram (2010) highlight a strong correlation between the Tel Aviv Creativity Test (TACT) and specific creative performance (specific CT), and between specific creative performance (specific CT) and academic knowledge (RLPS). These authors consider *a priori* that these correlations should be interpreted as cause-and-effect relationships (general CT → specific CT → academic knowledge) and that these relationships validate the domain-general hypothesis. But these correlations could very well be interpreted in a completely different way. Specific training probably impacts divergent thinking tasks (Fink et al., 2019): it is not unreasonable to think that TACT may be impacted by specific academic knowledge (richness of vocabulary, art practice, etc.). The socioeconomic status

of students' families (Tan et al., 2023) could also explain this correlation. Moreover, the method of assessing specific knowledge and specific creative performance is not exposed (in the method section or supplemental material). It invites researchers to adopt a very clear control of prior knowledge in the future. What knowledge (vocabulary, specific strategies, etc.) could help participants to succeed in such or such creative performance task? Do they already have this specific knowledge? In short, the content of the control task should depend closely on the content of the creative performance task.

Fink et al. (2020) train one group of 4<sup>th</sup>-grade students on verbal creative tasks and another group on figurative creative tasks. In this way, these students acquire specific knowledge that will later enable them to perform four creative tasks: a verbal divergent thinking task, a figurative divergent thinking task, a writing task (“Story Completion”) and a painting task (“Painting Picture”). This is a way of implicitly controlling some of the prior knowledge required to perform creative tasks (remember that Fink and his colleagues are the only ones to defend the general domain hypothesis and control prior knowledge). The results show that verbal training increases verbal (verbal divergent thinking task) *and* figurative (figurative divergent thinking task) creativity. The authors conclude that “this finding could also point to an interesting domain-generalness of the verbal training” (Fink et al., 2020, p. 683). However, this verbal training does not increase performance in creative or painting tasks. So, this does not show a “domain-generalness” of the verbal task, but rather its domain-plurality: there is specific verbal knowledge that can be used in divergent figurative and verbal thinking tasks, but this knowledge cannot be used in other creative situations (*e.g.*, writing task and painting task). In other words, specific knowledge can play a role in many fields (“domain-plurality”), but not all (they are not “domain-general”). The control of prior knowledge therefore failed to validate the domain-general hypothesis. On the contrary, it invalidated it (otherwise, verbal training would have increased creativity in all domains). This result is consistent with previous studies that control for prior knowledge and reject the general domain hypothesis (Bernal et al., 2017; Huang et al., 2017; Meier et al., 2023; Palmiero et al., 2019).

Barbot et al. (2016) offer participants four “Graphic” tasks (*Abstract Stimuli, Concrete Stimuli, Abstract Stimulus, Concrete Stimulus*) and four “Verbal-literary” tasks (*Story Titles, Story Characters, Story Endings, Story Beginnings*). In the first case, they have to complete drawings; in the second case, they complete stories orally. According to Barbot et al. (2016, p. 184), the results suggest that “general creative thinking-processes” would explain between 2.3 and 11.7 % of the variance (depending on the task). The rest of the variance would be explained by specific knowledge (“specific thinking processes”, “domain-specific skills”, “task-specific skills”). However, these “general creative thinking-processes” can only be a specific ability. As we have just seen, some knowledge can be useful in *several* areas (without being useful in *all* of them). There may be specific knowledge that can have a small impact in both the “Graphic” and “Verbal-literary” domains. This does not imply that it will have an impact in any domain or task. This more modest possibility (which is reflected in the results when prior knowledge is controlled) is worth considering before imagining “creative thinking-processes” that would have an



impact on all human knowledge. *In short, some participants succeed in creative tasks in several different domains (condition 1 is met) but only in experiments where prior knowledge is not controlled (condition 2 is not met).*

### **Are tasks from real life? (condition 3)**

*Who are the participants?*

Another important issue is that the participants are always students (first column, Table 1) and it is possible to be successful in several school or university disciplines at the same time. Students may memorize specific knowledge A to succeed in domain A, specific knowledge B to succeed in domain B, and so on. Thus, a student who succeeds in all disciplines may give the illusion that he possesses a general aptitude, when in fact he possesses only a mass of specific knowledge. Moreover, some specific knowledge (metacognitive strategies for memorizing information, spelling knowledge, calculation, etc.) can be used in several *academic* disciplines or situations (for examples of creative metacognitive strategies, see Rubenstein et al., 2018). The problem is the same when non-academic tasks (e.g., Divergence tasks, RAT) are proposed to participants (e.g., Beaty et al., 2013, Benedek et al., 2014, An et al., 2018). Divergence tasks (imagining different uses for the same object, creating unconventional word associations, originally completing a drawing, etc.) or the Remote Associates Tests (RAT) may not be so general. Each may require a certain amount of specific knowledge and this specific knowledge may have an important effect on performance. The only way to validate the domain-general hypothesis in an academic context would therefore be to rigorously control the participants' prior knowledge. In a non-professional environment (in which a participant is likely to have specific knowledge in several domains), this is the only way to ensure that prior knowledge is not the main cause of creative tasks performances. *Some participants succeed in creative tasks in several different domains but only in a non-professional environment (condition 3 is not met outside a school context).*

*Realistic tasks?*

Experiments therefore only take place in schools and universities. In addition, all creative performance tasks are artificial (third and fourth column, Table 1). Only May (2020) uses *one* academic task. In all articles, the creative tasks are designed by the experimenters (Table 1, column 3). Thus, these tasks do not show that participants can be creative in different professional or scholarly domains. There is no evidence that students can be creative in all disciplines: no study uses tasks developed *and* assessed by teachers. Mohamed et al. (2012) train evaluators, but that is not enough. It is important to choose *realistic* tasks (designed by teachers in the field) and *realistic* evaluators (e.g., teachers in the relevant field). Otherwise, creative performance tasks are not representative of the creative tasks that human beings perform daily.

Agnoli et al. (2016), Hong et al. (2013), and Hong and Milgram (2010) ask students to solve real-life problems (e.g., a student can't remember anything on the day of their mathematics test. What are all the things they can do?). Students' answers are indeed more or less original. However, these

problems are more artificial than realistic: indeed, they were designed by the experimenters. Hong and her colleagues are inspired by some interviews of students, but why choose one testimony rather than another? It would have been less artificial to have students develop these tasks and evaluate their degree of “realism”. More generally, as this systematic review shows for the first time, studies that defend the general hypothesis use *only* non-realistic tasks. Therefore, their results may only be valid outside the real-life context of human beings. *Some participants succeed in creative tasks in several different domains but only in experiments where tasks are artificial (condition 3 is not met).*

### **A confusion between function and functioning**

The final limitation of these studies is more theoretical than empirical. Some studies deduce the domain-general hypothesis from the existence of certain cognitive functions: whatever the domain (music, mathematics, painting, word associations, etc.), creative performance tasks are always performed by the same cognitive functions (Proposition 1), therefore creation is domain-general (Proposition 2). The validity of Proposition 1 does not however imply the validity of Proposition 2. One should not confuse the function with its functioning. For instance, working memory is involved in all tasks, but its efficiency varies according to the situation; its functioning essentially depends on the amount and quality of certain knowledge (for a review, see Ericsson et al., 2018) and on the specific qualities of the perceptible environment (for a review, see Hambrick et al., 2021). In brief, working memory is domain-specific even if it occurs in any domain. The function is domain-general (it contributes to the achievement of any task), but its functioning is domain-specific (its performance varies according to the domain).

The problem is that the domain-specific hypothesis does not imply that cognitive functions are domain-specific. It implies that their functioning (their performance) is domain-specific. In the “dual-process theory” (Chen et al., 2023), the default network combines knowledge and the executive control network also evaluates these combinations with knowledge. Certain knowledge is likely to be more effective than others: some knowledge improves the quality of the combinations; other knowledge improves the quality of the evaluations.

To say it differently, these two cognitive functions seem to use knowledge and their effectiveness seems to depend on the quantity and quality of this knowledge they handle or control. Therefore, the existence of these two functions does not invalidate the domain-specific hypothesis. On the contrary, the domain-specific hypothesis explains why these two functions specifically function: depending on the task, they use certain knowledge rather than others; thus, their performance is highly dependent on the amount and relevance of this specific knowledge they use (like any other cognitive function). In brief, it is not because the function is domain-general that its functioning is domain-general. The results obtained in neuroscience do not show that gray matter (neuron speed, etc.) has a real, positive impact on long-term creativity: the tests are too artificial and are only offered to students (only little-c creativity is taken into consideration). *Some neuroscientific studies give the impression that creativity is domain-*

*general only because they arbitrarily and implicitly confer a certain legitimacy on the following proposition (the mechanist domain-general hypothesis): if the neural mechanisms involved in creative tasks are domain-general then creativity is domain-general.*

### **Practical recommendations of domain-general theories (Educational recommendations 1 and 2)**

- (Educational recommendation 1 of minimalist theories) It is advisable to integrate general creativity training into school curricula or vocational training courses (*e.g.*, training in brainstorming or creativity self-assessment, inviting students to develop their creative personality, rethinking work environments).

This review of the literature does not allow us to formulate this recommendation. The absence of a prior knowledge test (condition 2) makes it impossible to know whether students are creating in relation to themselves (mini-c) or in relation to their peers (little-c). Success in creative tasks could therefore be explained entirely by the acquisition of a multiplicity of specific creative skills (*e.g.*, Schindler & Rott, 2017). At school or in ordinary life (little-c), specific skills are not yet very numerous: a student can acquire them all and succeed in all subjects. So, he or she may not need domain-general knowledge to be creative in all areas. Moreover, the creative tasks are not realistic even from a scholar point of view (limitation 3): they do not show that students are creative at school or university; students only succeed at artificial tasks that resemble school tasks (without being checked); these tasks are never designed and assessed by teachers in the field concerned.

- (Educational recommendation 2 of maximalist theories) It is advisable to select students or employees with a view to offering them educational or career paths more suited to their general creative profile (*e.g.*, creative mindset in all domains).

Nor does the present study allow us to make such a recommendation. The data do not show that a little-c student or employee is more likely to become pro-c or big-c later on: creative performance tasks are always carried out with students, and therefore remain little-c tasks. It is premature to select students or employees using psychometric tests. Secondly, it is not certain that these so-called general creative profiles exist. A student may believe he or she is creative without actually being so (at school, at work or in everyday life). There is no evidence that individuals create in the absence of prior knowledge testing (condition 2) or realistic creative tasks (condition 3). Self-reports do not show that a student is actually creative, and the data do not allow us to conclude that if a student says he is creative, he really is (success in a self-report creativity task → success in realistic creative performance tasks). To finish, just because creative processes are domain-general (mechanist domain-general hypothesis) does not mean that there is such a thing as a general creative personality or general creative skills.

### **Limitations of this work and future research**

This systematic literature review only reveals the weakness of the domain-general hypothesis. It does not prove the strength of the domain-specific hypothesis. “Whether creativity is domain-general

or domain-specific is one of the most enduring controversies in the field” (Teng et al., 2022, p. 55). Thus, it could be interesting to evaluate the domain-specific hypothesis with the same degree of requirement. “More research is needed to obtain a definitive answer to this issue” as Said-Metwaly et al. (2017) conclude in their systematic review for more statistical reasons (sample size, nationality of participants, etc.). Indeed, to our knowledge, there is no *systematic* review on the specificity of creation. The systematic review of Bicer (2021), which deals with both creation and the domain-specific hypothesis, is limited to mathematics education. Said-Metwaly et al. (2017) are interested in how creativity is measured. Their aim is not to directly test the validity of the domain-specific (or domain-general) hypothesis (even if this question occupies part of their “Discussion”). For this reason, they do not consider the actual content of the proposed tasks (whether they are realistic or artificial), the control of prior knowledge, or eliminate studies that use only self-reports (which is necessary to test the domain-general or even the domain-specific hypothesis). These are criteria that a systematic analysis of the literature on the specificity of creativity should take into account.

## Conclusion

The research question was:

- Are there any studies that defend the domain-general hypothesis (i.e., there is at least one general factor likely to have a significant positive impact on creative performance in any domain) and show that some people are able to succeed in creative performance tasks in different domains?

The answer is:

- Some participants succeed in creative tasks in several different domains (condition 1 is met) but only in experiments where prior knowledge is not controlled (condition 2 is not met) AND tasks are artificial (condition 3 is not met) OR it is postulated the following proposal: the function is domain-general therefore its normal functioning is partially or entirely domain-general.
- These limitations are too important to objectively validate the domain-general hypothesis (i.e., there is at least one general factor that can have a significant, positive impact on creativity) and its practical consequences (inclusion of general creativity training and/or selection of individuals; i.e., Educational recommendations 1 and 2).

Indeed, the results are both not very rigorous (no control of previous knowledge) and not very realistic (confined to the school or university domain; the creation tasks are never constructed by professionals or teachers of the domain). In addition, the existence of domain-general cognitive functions does not necessarily imply the existence of any domain-general functioning (do not confuse function and functioning): cognitive functions of creation use specific knowledge and their performance may depend primarily on the wealth of this knowledge.

Presently, it does not appear that humans, or even some of them, can be creative in any domain. From a more practical viewpoint, it remains more cautious for the moment to continue to focus on the

specific knowledge that can increase creativity in a particular domain. It may even be that some knowledge (e.g., certain metacognitive strategies) is efficient in several domains (not *all* domains; Chterelev & Panero, 2021).

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