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COMMENTARY

Culturally Fluent Theories, Metascience, and Scientific Progress: A Case Example: Commentary on Macnamara and Burgoyne (2023) and Burnette et al. (2023)

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Some ideas just feel right, others not so much. Familiar ideas are easier to process, seem to enjoy broad support, and are more likely to be accepted. Culture-based familiarity with the gist of an idea enhances the sense that things are as they ought to be. An idea's cultural fluency reduces the likelihood that people apply systematic rule-based reasoning strategies even when these would be appropriate. People shift to more skeptical reasoning strategies when ideas are unfamiliar and do not fit culture-based assumptions. This commentary applies a cultural fluency lens and a set of metascience principles to compare the meta-analytic syntheses of growth mindset interventions by Macnamara and Burgoyne (2023) and Burnette et al. (2023). In doing so, the commentary raises more fundamental questions about the relationship between theoretical claims, their popular acceptance, and the demanded level of evidence.

Public Significance Statement
When people consider an idea, policy, or theoretical claim, they often reason based on a gut sense that it feels right or does not. This gut feeling can be triggered by things external to whether the idea, policy, or claim really is right, including how familiar it seems. People have blind spots for the reasons behind their gut feelings so we outline ways scientists should go about testing and reporting to increase the chance that scientists and the public focus on the evidence and not gut-based feelings.

Keywords: growth mindset, interventions, metascience, culture, cultural fluency

> When you wish upon a star, makes no difference who you are,
> Anything your heart desires will come to you.
> If your heart is in your dream, no request is too extreme.
>
> —*When You Wish Upon a Star* (Harline & Washington, 1940)

Some ideas just feel right, others not so much. One determinant of this feeling is how easy or difficult it is to think about the idea (Schwarz, 2015). A number of factors increase such ease of processing, including whether the idea feels familiar because it fits with culture-based ideas and assumptions about human nature and how the world works. Following the culture-as-situated-cognition theory, culture-based familiarity with the gist of an idea makes the idea easy to process and enhances the sense that things are as they ought to be (Oyserman, 2015). This experience of cultural fluency can reduce the likelihood that people apply a systematic (rule-based) or mechanistic (how-based) reasoning strategy even in situations in which these shifting to these strategies would be appropriate. In contrast, ideas that do not fit well with culture-based assumptions feel harder to process. This culture-based metacognitive experience of difficulty shifts people from reliance on example-based reasoning to more rule-based and how-based skeptical reasoning. This may raise the bar on how much evidence is required. In this commentary, I consider the meta-analytic syntheses reported by Burnette et al. (2023) and Macnamara and Burgoyne (2023), which consider growth mindset interventions as a means of testing the growth mindset theory. The reports differ in their approaches and assessments. These observed differences raise more fundamental questions about the relationship between theoretical claims, their cultural fluency and popular acceptance, and the demanded level of evidence. This commentary has two parts. First, I address how cultural fluency influences how people engage with scientific theories, including the role of cultural fluency in metascience. Then, I apply this framework to the reports of Macnamara and Burgoyne (2023) and Burnette et al. (2023).

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Culture and Cultural Fluency

Culture

Culture is a human universal, a way of addressing the universal problems of social coordination, group loyalty, and the group need

for innovation (Boyd & Richerson, 2005; Lin & Oyserman, 2021; Oyserman, 2017; Oyserman et al., 2009; Schwartz, 1992). Each society develops its own way of addressing these universal problems (e.g., Hofstede, 1991). These solutions carry over to provide a way to organize experience.

Cultural Fluency

Culture provides people with rich, detailed, implicit, and explicit knowledge about associations (what goes together) and contingencies (how situations are likely to unfold). These culture-based expectations allow people to get through their days without much systematic reasoning (Oyserman & Jeon, 2022). Cultural expertise provides familiarity with a society's practices, ideas, assumptions, and artifacts. Familiarity increases people's ease of processing (Schwarz et al., 2021). People use both the content of their thoughts and the accompanying feelings of ease or difficulty in forming judgments (Schwarz, 2015). Hence, when people engage with practices and ideas of their own culture, they are likely to experience thinking as easier to do (as described in culture-as-situated-cognition theory; Oyserman, 2011, 2017). When considering culturally fluent ideas, people can apply their implicit assumptions about how the world works (Oyserman et al., 2014) and assume that things are as they should be (Lin et al., 2019). Culturally fluent ideas not only feel familiar, but they also feel *right*. Because culturally fluent ideas are congruent with people's implicit understanding of how "we" think and what "we" believe, these ideas seem obvious, inherent, and natural. They are positively value-laden and unlikely to trigger suspicion. Indeed, when experiencing cultural fluency, people are more likely to apply gut-level, heuristic processing—even in situations where they should apply rule-based reasoning (Mourey et al., 2015). In this way, cultural fluency provides a route to truth judgment and people are less likely to counterargue or seek disconfirming evidence for culturally fluent ideas (Oyserman, 2019).

In contrast, culturally disfluent ideas are incongruent with how "we" think and what "we" believe. Culturally disfluent ideas feel opaque, nonobvious, and even suspect or wrong. They are negatively value-laden. People experience cultural disfluency when their implicit culture-based expectations mismatch their observations in their own culture, whether these mismatches are on ideas, assumptions, or practices (Oyserman et al., 2014). Processing culturally disfluent ideas, thinking feels difficult. Indeed, people shift to more systematic reasoning and are less likely to nod along and go with the flow. People may be less persuaded by persuasion attempts when experiencing cultural disfluency, no matter the quality of the evidence (Oyserman & Yan, 2019).

One implication is that theories built on culturally fluent ideas will have a lower bar of acceptance. This inference is consistent with the general observation that fluent processing of mental content facilitates its acceptance (Schwarz, 2015, 2018). People are especially likely to experience fluency effects when their involvement with an issue is high rather than low, as involvement increases reliance on higher order thoughts and feelings as a heuristic to judgment (for a meta-analytic synthesis, Weingarten & Hutchinson, 2018). In contrast, rejecting or questioning culturally fluent theories will feel suspect and require a higher bar of proof.

Growth Mindset Interventions

Since Dweck's (Dweck & Bempechat, 1983; Dweck & Leggett, 1988) initial proposal, what is now termed *growth mindset theory,* has received broad attention, acceptance, and public acclaim, particularly concerning its translation into interventions. The theory contrasts a *growth* mindset with a *fixed* one. The former entails the belief that intelligence and ability are malleable and the latter that intelligence and ability are fixed and do not change. Growth mindset interventions seek to foster a higher endorsement of the idea of a growth mindset as a critical proximal outcome. Attaining a growth mindset is predicted to trigger a cascade of shifts in expectations of success, willingness to persist, and mastery-oriented behaviors (Burnette et al., 2023). Macnamara and Burgoyne's (2023) meta-analysis challenges the basis for the public acceptance of academic growth mindset interventions. They draw attention to inconsistent effects and a scarcity of process evidence that can support the assumption that changes in growth mindset trigger the predicted shifts in self-efficacy and related expectations of success, willingness to persist, and mastery- (or performance-) oriented behavior that themselves yield academic success. Drawing on a different selection of studies that bear on a wide range of outcomes, including academics, health, and social functioning, Burnette et al. (2023) concluded that growth mindset interventions show positive and promising results. The results of these two approaches are not directly comparable because they are based on different studies. Burnette and colleagues' analysis includes only a subset of the academic intervention studies included by Macnamara and Burgoyne and includes intervention studies in domains in addition to academics to examine the process.

The Cultural Fluency of Personal Growth

Consider the case of individualism, doing one's own thing, which is a core value in the United States. In brief, most Americans assume that people are free to create themselves and that this entails following their passion and doing what feels intrinsically motivating (Deci, 2004; Deci & Ryan, 2008, 2012; Li et al., 2021). From an American perspective, doing one's own thing by following one's passions should yield positive distinctiveness—a favorable comparison to others on a culturally valued dimension. Not being positively distinctive is, by implication, a failure of drive, effort, or will. Various theories of motivation fit this cultural frame. Deci and Ryans' self-determination theory of intrinsic motivation predicts that having intrinsic motivation is healthier and more likely to yield the intended results. Self-efficacy theories predict that people are more likely to succeed if they believe they have the potential for future success and believe in their abilities (e.g., Bandura, 1997). Achievement goal theory contrasts a mastery orientation with a performance orientation and learning goals with performance goals (Dweck & Leggett, 1988). With this perspective, mastery and learning goals are intrinsic motivations, while performance goals are not (Heyman & Dweck, 1992).

Dweck's growth mindset formulation builds on these core perspectives and adds that to trigger academic success, students must believe that their intelligence can grow (Molden & Dweck, 2006). This belief is termed a *growth mindset of intelligence*. Higher growth mindset scores may directly affect student academic success or uniquely trigger willingness to engage effortfully by turning on intrinsic motivation, academic self-efficacy, mastery, and learning-focused beliefs. Most

growth mindset studies took place in the United States. However, emerging evidence suggests that people living in other societies and cultures may endorse both ideas—that people differ in their intelligence (a fixed theory of intelligence) and that abilities can change (a growth theory of competence). Indeed, Americans find the belief that intelligence cannot change incompatible with believing that ability can change with effort (as evidenced by strong negative correlations between growth and fixed mindset items and a single reverse-coded scale). However, people in other cultures seem to hold both ideas in mind as separate, not opposite (e.g., China: Chan, 2012; Zhen et al., 2022; India: Kevin & Risla, 2020; Japan: Potsangbam & Barman, 2019, see also Gouëdard, 2021; O'Donnell et al., 2021).

The culturally fluent idea for Americans is that believing in growth unlocks potential—thus, for example, the saying "in America, anyone can become president." Given that, what differs between high and low achievers is belief, and people who believe that they can are assumed to be invigorated through intrinsic, efficacy-focused engagement. That this idea is culturally fluent can be seen in popular sayings and cultural artifacts. Consider, for example, the *When You Wish Upon a Star* signature song of the Walt Disney Company (see opening epigraph of this article; Harline & Washington, 1940), this music plays in the opening of its shows and movies with visuals of the magic kingdom, fireworks, and a shooting star. Within American culture, true desire and the right motivation (whether described as wishing upon a star, believing that the sky is the limit, or reaching for the stars) transform and change one's essence. In the United States, rags to riches, pull yourself up by your bootstraps, and related beliefs form the basis of a booming industry of self-help books. Their general arc is that anyone can do and be anything if they just vividly imagine, truly want, and rely on their innate strengths. In effect, the culturally fluent frame makes the alternative unclear. If you cannot become anything you want, what does that imply? That any failures are your fault? That you should stop trying to be anything at all? Cultural fluency with the former idea may blind us to myriad alternative possibilities. It is not that culturally fluent ideas are right but rather that they are more likely to *feel right* simply because they are familiar. Of course, it is also not that culturally fluent ideas are wrong; rather, their familiarity makes them less likely to be scrutinized.

Processing Claims and Evidence: Applying a Metascience Approach

Claims and Evidence

Many scientists believe that "extraordinary claims require extraordinary evidence" (Sagan, 1979, p. 62). While some may counter that all claims need solid evidence (Deming, 2016), there is little doubt that claims experienced as compatible with established knowledge face fewer evidentiary demands. Unfortunately, the perceived compatibility of new claims with already established knowledge may be less based on empirical evidence than on a culture-based metacognitive experience of ease and familiarity with the gist of the idea (Oyserman, 2011, 2015).

Taking a Metascience Approach

Metascience is the study of science and scientific progress—how scientists can learn from, develop and add support to, or diminish confidence in, claims made from prior studies (Gholson et al., 1989; Ioannidis et al., 2015). Hence, metascience can be used to outline a roadmap for how claims can be considered. In this commentary, I consider three aspects of a metascientific perspective: what makes a theory feel right; what facilitates stringent empirical testing; and what facilitates the reproducibility of theory tests. Philosophers of science highlight that theories start with values and basic assumptions about human nature (Deutsch & Krauss, 1965; Losee, 1993; Merton, 1942; Stevenson & Haberman, 1998). I use the culture-as-situated-cognition theory to highlight why this starting point matters (Oyserman, 2015). Good theories are testable, refutable, and compatible with what is known, and make novel predictions (Albert, 1968; Deutsch & Krauss, 1965). I address these aspects of metascience by considering a theory's process model, whether relevant concepts are operationalized, and whether theory-relevant moderators are addressed. Third, metascience emphasizes the need for open science practices to facilitate the reproducibility of findings (Fanelli, 2009; Harris, 2017). I address this aspect by considering the openness of decisions, including decisions regarding analysis, the handling of missing data, the presentation of full data sets, and the discussion of conflicts of interest.

What Can Meta-Analytic Syntheses Tell Us About Growth Mindset Interventions?

Macnamara and Burgoyne (2023) and Burnette et al. (2023) each present a meta-analytic summary of growth mindset interventions. Readers of either one might well assume that what they have is a full report that they can use to draw conclusions and make progress. As detailed next, in some ways, this assumption is correct. In some respects, readers of either report would draw the same conclusions. Yet, in other ways, readers are led to draw sharply divergent conclusions.

First, I consider points of convergence: Both teams agree that most of this literature focuses on interventions in school to improve students' academic outcomes. Both teams agree that write-ups underspecify what these interventions entail, whether and by what process they create or cue a growth mindset, and that documenting an intervention's effects on growth mindsets matters if interventions are to be considered tests of the theory. Both teams infer that growth mindset interventions also trigger other psychological processes that influence academic outcomes, that write-ups are unclear about how the interventions do so, and whether changes in growth mindset are necessary for these other processes to occur. Both teams note that these omissions make it difficult to test the process by which a growth mindset affects change in academic outcomes and that process matters if interventions are to test the theory. Without testing the theoretically relevant process from growth mindset to effort and efficacy, assessments of the intervention do not test a predicted mediated distal effect but instead a direct main effect. That direct main effect, simply put, is the possibility that believing in a growth mindset of intelligence (i.e., believing that intelligence can change) somehow directly yields effects on academic outcomes.

In terms of effects, Macnamara and Burgoyne (2023) attained an effect of $d = 0.05$ overall, an effect of $d = 0.04$ for studies measuring a change in the growth mindset of students and an effect of $d = 0.02$ for studies with higher quality (as operationalized in their article). Neither of these latter two effect sizes reached significance. These results do not substantively differ from the results of the prior meta-analytic synthesis of this team (Sisk et al., 2018). Burnette et al. (2023) find 53 studies across three outcomes (academic, mental health, and social). In their abstract, they report an effect on academic

outcomes of $d = 0.14$, 95% CI [0.06, 0.22]. In Table 3 of their article, they report an effect of $d = 0.09$, 95% CI [0.05, 0.13] for academic outcomes. They note that their estimated effect is within the confidence interval of their prior work (Burnette et al., 2013).

Thus, both reports find small effects, and Burnette et al.'s (2023) effect size overlaps the 0.02–0.09 confidence interval of the 0.05 effect reported by Macnamara and Burgoyne (2023). In that sense, though not directly comparable given, as detailed below, their largely nonoverlapping data sets, the two quantitative syntheses find complementary results. On the other hand, the reports differ in the roadmap they provide for scientific progress. This latter point is my focus. Macnamara and Burgoyne (2023) start with a culturally disfluent theme, which is that growth mindsets (believing that intelligence can change) may not be enough to produce a positive change in academic outcomes by themselves. Assuming that their evidence will be met with disbelief and suspicion, they approach their task systematically and anticipate potential counterarguments. Being skeptical matters; it increases the systematic examination of claims, processes, evidence, generalizability, and links to other theories and evidence. In contrast, Burnette et al. (2023) seem to start with the culturally fluent theme, which is that growth mindsets are the difference between success and failure. Such culturally fluent propositions are likely to feel right and to be well-received rather than contested and counterargued, which may influence the extent to which one needs to prepare for skeptical readers.

Applying a Cultural Fluency and Metascience Lens

Next, I consider seven ways in which these two approaches yield different perspectives using a synthesis of a cultural fluency lens and the themes highlighted by a metascience approach as my organizing structure. Following suggested metascience practices regarding methodology, reporting, reproducibility, evaluation, and incentive practices could serve as a counterweight to our human propensity to nod along and accept culturally fluent ideas as sound and reject culturally disfluent ones as suspect and unlikely to be true. I consider aspects relevant to theory testing (process models, operationalization of constructs, theory-driven subgroup analyses) and aspects relevant to openness, reproducibility, and studies as building blocks (transparency of researcher decisions, including researcher degrees of freedom regarding reporting of handling of missing data and other aspects of analyses, coverage of the full population of studies, and conflict of interest). Sections focus on first, theory process models; second, theoretical concepts and their operationalization; third, theory-relevant subgroup analyses and their report; fourth, disclosure of decision rules; fifth, coverage of the full data set or literature; sixth, transparency of researcher degrees of freedom; and seventh, conflict of interest. A cultural fluency lens suggests that the teams will differ in their choices and the conclusions that they draw. As an overivew, Table 1 presents each of these aspects of metascience and summarizes how attention to them can help policymakers, readers, and researchers.

Process Models

Macnamara and Burgoyne (2023) seek out and report on studies that test the specified or implied theoretical process in simultaneous analyses rather than as a series of piecemeal examinations of separate correlations. The available process data allow for a test of whether mindset interventions are more likely to show positive effects if they include documentation of a change in mindset. Macnamara and Burgoyne test and fail to find support for this process reporting that the reverse may even be the case. The potential implications of this conclusion are useful for theory development and should not be ignored. One possibility is that the active ingredient of growth mindset interventions is something other than changing people's beliefs about growth mindsets. For example, these interventions may change people's academic efficacy (the belief that if they try, they can succeed) or they may change people's focus on learning goals. Another possibility is that actual changes in belief in a growth mindset are not captured by the measure. Being open to both possibilities would allow for theory development. Burnette et al. (2023) draw on separate analyses of individual process elements, assessed in different studies, to evaluate the overall process models. They conclude from the separate pieces that the process model fits the data. As detailed below, a direct comparison of the two sets of results is impossible. The majority of the studies reviewed by Macnamara and Burgoyne are not included in the analyses of Burnette and colleagues and the Burnette team includes studies focused on nonacademic outcomes. These studies may differ in other ways from studies that focus on academic outcomes (e.g., in the effect of growth mindset on the dependent variable or in the interventions themselves).

Concepts and Operationalizations

To be testable, a theory's concepts need to be operationalized into documentable manipulations (interventions in this case) and relevant measures of process and outcomes. Both teams highlight a lack of specificity as to what exactly mindset interventions do—the process by which they influence outcomes. They note that few of the study reports describe measuring a change in mindset as part of the validation of the intervention process and that authors typically fail to measure other implied active ingredients (e.g., belief that the brain changes, belief that effort matters, academic efficacy, and positive expectations for success). Each of these is potentially an active ingredient for intervention and rooted in theoretical frameworks that also could lend themselves to intervention.

The issue, as raised by Macnamara and Burgoyne (2023), is whether the intervention can be used to establish the validity of the growth mindset theory. Their concern about whether interventions provide an informative test of the theoretically assumed processes is separate from whether researchers do or do not find a significant effect of random assignment to conditions on academic outcomes. Macnamara and Burgoyne focus on the subset of studies that do measure a change in growth mindset and suggest that higher quality studies should yield larger effects. Macnamara and Burgoyne find a small effect $d = 0.04$ that becomes nonsignificant once quality criteria are added.

Of course, if the various studies are presenting interventions with different active ingredients, effects might be canceling each other out. In their summary tables, Burnette et al. (2023) provide evidence of the large heterogeneity of effects among growth mindset interventions. In this sense, both meta-analytic summaries highlight a lack of clarity in three regards. First, what the growth mindset interventions entail; second, how intervention components operationalize growth mindset; and third, whether these interventions also trigger other active ingredients that yield effects separately from a change in a growth

Table 1
Describing Aspects of Metascience and Their Use for Advancing Science and Policy Application

Metascience aspect	Description	Uses for advancing science
	Values and basic assumptions about human nature	
Theories are cultural products	Theories start with values and basic assumptions about human nature.	1. Theories vary in the extent to which they feel easy to process. 2. Ease of processing can be a signal that the theory's propositions are higher in truth value but can also be a signal that the propositions are a good fit with culture-based ideas. 3. Culturally fluent ideas may not be interrogated with the same skepticism as culturally disfluent ones.
	Theory building	
Process models	Process models specify the theory-predicted path by which a predictor influences an outcome. Such models may attribute all or some of the variance to predicted mediators and/or moderators. Process models outline how moderators enhance, dampen, or eliminate effects.	1. Theory testing entails explication and empirical examination of the theorized process as operationalized in the process model. 2. A useful first step entails a piecemeal examination of theorized mediators and moderators. 3. An understanding of the process is necessary to assess if an intervention produces an effect due to the posited process, due to nonspecified active ingredients, or to features of the context that may undermine both theory testing and subsequent ability to replicate effects or compare effects across intervention models. Hence, an intervention tests a theory if theorized mediators or moderators are simultaneously included.
Concepts and operationalizations	Operationalization entails specifying how exactly each theoretical construct (the predictor, mediators, moderators, and outcomes) was measured or manipulated. Operationalization is distinct from labeling.	1. To be testable, a theory's concepts need to be operationalized into documentable manipulations or interventions and measures of process, outcomes, and intervention fidelity. 2. Without this documentation, readers are left to associate meaning with the labels, leading to inferences that may or may not be warranted by results and undermining the application of results. 3. Clear operationalization allows for connection across different empirical and theoretical literatures that may be studying similar operationalizations with different labels.
Subgroup analyses	Subgroup analyses, a form of moderator analyses, entail analyses of separate effects within subgroups of the full sample or population assessed. If a theory is predicted to apply only among certain groups or in certain conditions then subgroup analyses can be specified a priori, and sampling can be done to support powered tests of the predicted subgroup effects. Alternatively, subgroup analyses can be considered exploratory analyses for use in theory building	1. Subgroup analyses can be important for scientific advance as theories may specify the conditions in which the theorized process is enhanced, dampened, or eliminated. 2. If the theory was initially presented without these limiting conditions, subgroup analyses are exploratory and can lead to theory refinement. 3. If the theory was initially presented as relevant only in certain conditions, the predicted interaction effects are confirmatory and a failure to find them suggests that the theory is misspecified. 4. Subgroup analyses can be exploratory. For example, dropping some participants from treatment groups can provide exploratory evidence of subgroup effects.
	Synthesizing, building, and reproducibility	
Disclosure of decision rules	Unpacking process: the decision rules used at each step of the process. Sharing the information needed to carefully examine how the research was conducted (e.g., design and methods, how syntheses are composed)	1. Assists readers in understanding what a particular study found. 2. Situates meta-analytic results within the relevant body of work—what has and what has not been supported in prior studies. 3. Highlights gaps—which theoretically relevant processes have not yet been tested. These can be addressed in new studies.
Coverage of the full data set	Amassing and examining all data or sources of data (e.g., sharing data from publications and preprints) and other ways to increase reproducibility. Providing a detailed rationale for each choice to include or exclude cases or data when considering preprints and publications using the same data source.	1. Assists readers who wish to replicate a study. 2. Allows for the rationale for choices of including or excluding cases or data to be debated. 3. Allows for considering external validity—to what population of effects or underlying processes the evidence generalizes. 4. Sharing the full set of data sets a clear framework for possible future work by highlighting anomalies that can be explored for hidden limiting conditions or confounds.
Transparency (researcher degrees of freedom)	Clear reporting of choices regarding analysis, which data to report, and how to handle missing data. In intervention research, reporting choices regarding how to handle differences in intervention take-up among people randomized to treatment conditions.	1. To assess real-world likely effects, policymakers may prefer to know the difference between groups assigned to different treatments (whether they received the treatment or not). 2. To assess whether an intervention provides evidence relevant to testing a theory, more complex statistical techniques preserve randomization while examining effects among the kind of individuals who would take up treatment if offered across treatment and control groups.

(*table continues*)

Table 1 (*continued*)

Metascience aspect	Description	Uses for advancing science
Conflict of interest	Conflict occurs when research is funded by or conducted by people employed by bodies that stand to gain financially from results being found in a particular direction. Conflicts of interest are enumerated in institutional review board certification because nonreported potential conflicts of interest can impede full assessment of the implications of reports.	1. Conflicts of interest can impede accurate assessment of the implications of reports. If potential conflicts of interest are rarely or never reported, testing if these potential conflicts matter becomes impossible. 2. Although it stands to reason that interested parties fund research, once findings are available then potential conflict of interest effects can be studied by comparing the results of studies with and without these potential conflicts. 3. If such conflicts appear to matter, follow-up studies can be conducted to the extent that the results are of public interest.

Note. Metascience highlights ways to support the progression of science. These constructs were developed from the presentations of Oyserman (2019) and especially Ioannidis et al. (2015).

mindset. In terms of scientific progress, this lack of clarity means that how a growth mindset fits with or contradicts other theories of motivation remains unclear.

Tests of Moderation (Subgroup Analyses)

Both teams ask which theory-relevant conclusions can be drawn from subgroup analyses. Subgroup analyses can be important for scientific advance if a theory turns out to apply only when certain conditions are met. If the theory was initially presented without these limiting conditions, subgroup analyses are exploratory and can lead to theory refinement if they prove stable in subsequent work. If the theory was initially presented as relevant only in certain conditions, the predicted interaction effects are confirmatory and a failure to find them suggests that the theory is misspecified.

Both author teams examine if a growth mindset only matters for adolescents, only matters for students whose grades are below the median in their school, only matters for students who are from groups stereotyped as not doing well in school, or only matters before a test. Macnamara and Burgoyne (2023) do not find interaction effects and hence do not explore subgroup analyses. Burnette et al. (2023) examine interaction effects.

What neither of these articles does and what would be useful for scientific advance, is to ask what these effects, if found, imply for the theory and its application in school settings. That is, if the growth mindset intervention is only predicted to change academic outcomes at particular times or with particular subgroups, how can findings supporting these limited effects be used to clarify the theory and its attendant process model? Do people for whom growth mindset intervention is not posited to matter already have a high belief in a growth mindset or do they not need to have a high belief in a growth mindset? Would people for whom growth mindset intervention is not posited to matter leverage different beliefs that are relevant to the idea of a contrast between fixed and growth mindset beliefs—for example, a belief in using one's fixed capacity to the maximum? The issue is not which are the best next questions, but rather, to consider what questions differential subgroup effects imply for the theory in general.

Disclosure

Metascientists advocate for careful examination of how research is conducted—including its design, methods, how syntheses are composed, and openness and ethics of research collaborations. Hence, one aspect of taking a metascience approach as a researcher is to be transparent and disclose to readers the decision rules used at each step of the process, assuming that readers will otherwise be skeptical rather than trusting of results. Both Macnamara and Burgoyne (2023) and Burnette et al. (2023) have previously conducted meta-analytic syntheses of the mindset literature. In disclosing this information, Macnamara and Burgoyne explain exactly what is new in the current analyses, and how they use the literature reviewed in their prior synthesis. They list each of their decision rules for inclusion and their rationale. They critically read each article, noting both discrepancies between the data presented and the way results are verbally described (e.g., Aronson et al., 2002; Good et al., 2003) and problems in drawing inferences from results as initially analyzed (e.g., Blackwell et al., 2007). This skepticism is not found in the report of Burnette and colleagues, who describe studies using the results and language found in the initial write-ups.

Coverage

Metascientists advocate for a holistic approach to science, considering preprints and sharing of data and other ways to increase the reproducibility of science. One aspect of taking a metascience approach is to amass and examine all sources of data and provide a detailed rationale for each choice so that the work can be replicated and the rationale for choices debated. Regarding covering the population of studies included in the meta-analyses, Macnamara and Burgoyne (2023) examine the preprints and unpublished versions of studies as well as the published articles and use the fuller data set for each study unless a rationale for data exclusion is provided. They found 96 effects, 70 of which are not included in Burnette et al. (2023). Conversely, the academic outcome studies included by Burnette and colleagues are discussed by Macnamara and Burgoyne. Going beyond Macnamara and Burgoyne's focus on academic outcomes, Burnette and colleagues focus on academic outcomes and also include studies across an array of other outcome measures. Knowing the choices and the rationale for making them allows readers to agree or disagree—a systematic approach, which is reflected in the Macnamara and Burgoyne approach. Burnette and colleagues do not provide a rationale for excluding the 70 studies reported by Macnamara and Burgoyne and their description of associations between theoretically interesting mediators does not distinguish studies examining interventions across different outcomes. Without this information, readers cannot form a judgment as to which approach to follow.

Transparency

Macnamara and Burgoyne (2023) highlight the degrees of freedom researchers have in choosing which data are to be analyzed and which analyses are reported. They seek out full data sets where available and use those when a rationale for dropping cases is not provided. Their skeptical lens highlights differences in results when data are included versus excluded. They articulate specific concerns with any intervention-based research beyond the set of growth mindset interventions they are examining.

Macnamara and Burgoyne (2023) note that no matter the form of analyses, researchers often fail to fully specify exclusions. Dropping data without a fully specified rationale undermines causal inference. Inferences can no longer be based on the assumption that the only difference between the groups is random assignment to treatment and control. When randomization occurred at the population level, dropped cases can only support exploratory analyses of possible effects. A separate concern is that researchers may verbally describe their results in ways that are inconsistent with what their statistical effects show or may publish a version that drops data and shows an effect not otherwise found. Each of these undermines scientific advances if effects that are unlikely to be stable enter the public discourse.

In addition to data inclusion choices, researchers make analysis choices. An important distinction in intervention research is whether the analysis is based on "intention to treat" or something else. An *intention-to-treat* analysis compares the group randomly assigned to receive an intervention to the group randomly assigned to something else, independently of whether the intervention was provided as planned or participants engaged with it as expected. This comparison is important for policymakers who want to know if there is an average effect of the intervention, separate from how well it is implemented and if people offered the intervention participate in it.

However, intention-to-treat analysis is less useful for researchers wanting to use an intervention to test a theory. As both author teams note, if intervention results are meant to test a theory, researchers must apply a more specific approach to answer a more specific question. In this case, the question is whether people who were randomly assigned to receive the intervention and received it "per protocol" differ from people who were randomly assigned to not receive the intervention but would have taken it up if it had been offered. This analysis, termed *complier average causal effects* or CACE, is more complex (Dunn et al., 2005; Emsley et al., 2010). It requires that researchers be able to measure a variable distinct from the treatment that predicts being present for or engaging with the intervention. One version of CACE is termed the *local average treatment effect* (LATE). LATE also requires that the effect of this third variable be linear (Barua & Lang, 2016; Imbens & Angrist, 1994).

Alternative approaches, called "treatment on the treated" or "per protocol" analysis compare people from the treatment group who received the treatment with people in the control group. These approaches fail to preserve the causal inference benefit of randomization and the analyses using these approaches are best considered exploratory. Yet, readers would like to draw causal inferences. They want to know not only if an intervention yields effects but also whether the process by which effects are attained supports the theory (Emsley et al., 2010). Preserving causal inference is all the more critical if the to-be-tested theory entails mediation (e.g., that a growth mindset matters only if it triggers effortful engagement and efficacy) or moderation (e.g., that a growth mindset intervention only matters when delivered in situations in which effortful engagement and efficacy matter; Emsley et al., 2010).

A final issue entails the extent to which the intended intervention was delivered and received as intended, termed *fidelity*. Neither of the author teams details issues in source reports in this regard, potentially because fidelity often does not come to mind and readers assume that whatever was intended was fully delivered or else the researcher would have told them so. Yet, researchers often fail to document their a priori protocol for assessing fidelity (Durlak & DuPre, 2008). This lack of documentation is particularly a problem for researchers wanting to draw inferences from interventions to theory, as noted by both research teams. It is impossible to determine the extent to which an intervention was delivered with fidelity and what proportion of those offered a treatment actually engaged with it unless reports provide the relevant information.

Conflict of Interest

In addition to reporting decision rules, metascience highlights the need to routinely report conflicts of interest as both can impede full assessment of the implications of reports. As noted by Ebrahim et al. (2016), reports often differ when authors have conflicts of interest, yet conflicts or potential conflicts are rarely disclosed. Macnamara and Burgoyne (2023) note that financial conflict of interest is atypical in psychological research and hence may not be included in weighing evidence. Both teams point to mindset research as unique in that school-based growth mindset interventions are sold through a for-profit portal (Mindset Works, Brainology) that is affiliated with central growth mindset academics who may also seek to earn side incomes through speakers' bureau sites. Macnamara and Burgoyne note that this information should be clearly stated so that it becomes part of the scientific record, especially since some of the more widely known growth mindset intervention studies come from this pipeline.

Summary, Conclusions, and Future Directions

In sum, meta-analytic research includes an examination of how the included research was conducted, reported, verified, incentivized, and evaluated (Ioannidis et al., 2015). Macnamara and Burgoyne (2023) take on this task. Doing so highlights the many ways in which core questions remain, despite the broad popularity and influence of the growth mindset theory. These yet unanswered questions include what a growth mindset intervention entails; how a growth mindset intervention affects academic outcomes; and whether observed changes in outcomes are due to changes in growth mindset or some other ingredient of a complex intervention.

Growth mindset interventions may be popular in part because their focus feels culturally fluent, and hence, true to people applying an American cultural lens whether they are researchers, readers, funders, or other members of the public. For Americans, the fluent idea may be that anyone can be anything if they wish for it—that with the right perspective, people can succeed. Hence, growth mindset interventions may feel right even though they do not consistently document that changing growth mindsets is what triggers effortful engagement. This is a missed opportunity to the extent that effortful engagement is necessary for growth mindset to matter (as the theory predicts). The more culturally fluent a

proposition is, the less likely people are to apply a skeptical, systematic lens in processing information pertaining to it. This failure to shift to a systematic reasoning frame impedes scientific progress and does not facilitate the advances that come from attempting to refute a theory or to test the conditions in which it does or does not apply (Lakatos, 2015; Popper, 1962).

In the case of growth mindset theory, the self and motivation literature provides fertile ground for development. The lead author, Carol Dweck, has a long and productive set of ideas relating to children's motivation, as do both the field of achievement motivation (e.g., Wigfield et al., 2021) and researchers studying self and motivation (e.g., Oyserman et al., 2012). By taking on the culturally disfluent idea that wishing may not make your dreams come true, Macnamara and Burgoyne (2023) provide a service to continuing scientific inquiry. A key goal of a quantified meta-analytic synthesis within a metascience approach is to specify levels of confidence in the process model offered by a theory. Doing so allows the broader scientific community and public to build on components of the theory that are well supported and to let go of components about which confident conclusions cannot be drawn. The results of both meta-analytic syntheses highlight the need to consider what the growth mindset theory predicts, and how it is congruent with, or contradicts, the assumptions of other theories of academic motivation, engagement, and improvement. Taking a disfluent lens can highlight gaps that would otherwise be missed. Highlighting gaps makes space for new research and this new research can facilitate better synthesis across seemingly conflicting or contradictory bodies of evidence. That is the purpose of scientific inquiry.

Culturally fluent theories have a higher intuitive appeal. Their intuitive appeal facilitates the theories' acceptance but comes at the risk that researchers themselves adopt a less critical lens than they would if they felt that they face a highly skeptical audience. When reviewers share the cultural assumption, the gaps may be less apparent and/or seem more tolerable. Those who draw attention to the gaps may face an uphill battle. Both cultural fluency and cultural disfluency can shape the science we create.

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