Philosophia (2022) 50:2441–2456
https://doi.org/10.1007/s11406-022-00565-1

Theories of Independent Intelligences as a Lakatosian Research Program

Jonathan Egeland[1]

Received: 15 February 2022 / Revised: 16 July 2022 / Accepted: 1 August 2022 /
Published online: 11 August 2022

Abstract
Theories of different and independent types of intelligence constitute a Lakatosian research program, as they all claim that human intelligence has a multidimensional structure, consisting of independent cognitive abilities, and that human intelligence is not characterized by any general ability that is of greater practical importance, or that has greater predictive validity, than other, more specialized cognitive abilities. This paper argues that the independent intelligences research program is degenerating, since it has not led to novel, empirically corroborated predictions. However, despite its flaws, the program provides an illustrative example of some of the philosophical problems that inhere in Lakatos's so-called "methodology". Indeed, Lakatos's conceptions of the *negative heuristic*, the *positive heuristic*, and the relationship between scientific *appraisal* and *advice* are all vulnerable to objections. The upshot is that theories of independent intelligences indeed teach us more about philosophy of science than about the nature of human intelligence.

Keywords *g* · IQ · Independent intelligences · Multiple intelligences · Triarchic theory · Lakatos · Research program · Cognitive ability

1 Introduction

What is the nature and structure of human intelligence? For more than a century, researchers have argued and discussed this question, often focusing on whether human intelligence is a general cognitive ability that influences all other cognitive abilities, or whether it is a set of different and independent cognitive abilities (Spearman, 1904, 1927). Most intelligence researchers today endorse the former perspective, accord-

✉ Jonathan Egeland
jonathan.egeland@uia.no

[1] University of Agder, Kristiansand, Norway

ing to which there is a *g* factor that emerges from the *positive manifold*—i.e., from the positive correlations of scores on different cognitive tasks—and that reflects a general cognitive ability in the human mind (Reeve & Charles, 2008; Rindermann et al., 2020).[1] This naturally became the dominant view in the 1990s, when Carroll (1993) factor-analyzed about 450 datasets from 19 different countries, almost all of which produced a hierarchical factor structure with *g* at the top. Moreover, only five years later, Arthur Jensen published *The g Factor: The Science of Mental Ability* (1998), convincingly arguing that the *g* factor receives a wealth of support from the empirical evidence, and that it is one of the most important psychological constructs ever discovered (cf. Bouchard, 2014; Panizzon et al., 2014; Ree & Carretta, 2022).[2]

However, despite several decades of research supporting the idea that human intelligence is a general cognitive ability that contributes to one's performance on all cognitive tasks, the opposing perspective claiming that there are different and independent intelligences remains remarkably popular, especially in educational circles (Hunt, 2011; Klein, 1997).[3] Indeed, theories of independent intelligences (such as Gardner's multiple intelligences theory) are among the most commonly taught topics in introductory psychology textbooks (Griggs et al., 2004; Warne et al., 2018), and the vast majority of both teachers and members of the general public endorse the claim that there are many different types of intelligence (Schroth & Helfer, 2009; Warne & Burton, 2020).[4]

Given that ideas about independent intelligences appear to be tremendously resistant to both theoretical problems and empirical refutations, the purpose of this article is twofold: first, by using Lakatos's conceptual framework for understanding and evaluating scientific theories, it will argue that theories of independent intelligences constitute a degenerating, rather than progressive, research program; second, it will

[1] Rindermann et al. (2020, p. 4) found that 76% of experts endorsed a general factor perspective. This represents an 18% increase from the results of the earlier survey by Snyderman & Rothman (1988). It must, however, be noted that a weakness of the survey results of Rindermann et al. (2020) is that they may not be representative of the views of all experts, and especially not of female or non-Western researchers. They note that "An underrepresentation of viewpoints associated with experts' background characteristics (i.e., political views, gender) may distort research findings and should be addressed in higher education policy." Future studies should therefore work to amend this limitation, by gathering and analyzing data from more representative samples.

[2] However, it must be noted that proponents of the *g* perspective on human intelligence neither deny that there are specialized cognitive abilities, nor that they are of practical importance. In fact, the Flynn effect, which refers to the dramatic increase in phenotypic IQ during the 20th century (of 3 points per decade on average), and which arguably has enabled us to thrive in today's highly technological and fast-paced societies, does represent an improvement in such specialized abilities, rather than *g*. For more on this, see Carroll (1993, pp. 27–28); Flynn (2012, 2013); Rindermann & Becker (2018); Woodley (2012). Moreover, there is also some disagreement among the proponents of the *g* perspective as to whether the folk-concept of intelligence is fully captured by *g*, or whether it includes other cognitive abilities as well. For different perspectives, see e.g. Carroll (1993, pp. 591–599) and Haier (2017).

[3] Although proponents of the latter perspective nowadays usually concede that (at least some) cognitive abilities are correlated, they tend to either interpret the *g* factor that emerges when ability tests are factor analyzed as merely a statistical phenomenon, or to downplay the relative importance and predictive validity of *g* (e.g., Sternberg et al., 2000, p. xi).

[4] In their sample of both teachers and non-teachers ($n = 551$), Warne & Burton (2020) found that 84.4% endorsed the false claim that "There are many different types of intelligence, such as musical-rhythmic intelligence, verbal-linguistic intelligence, and bodily-kinesthetic intelligence".

use the independent intelligences research program in order to illustrate three fundamental problems with Lakatos's framework, having to do with his conceptions of the *negative heuristic*, the *positive heuristic*, and the relationship between scientific *appraisal* and *advice*. The upshot will thus be that theories of independent intelligences indeed teach us more about philosophy of science than about the nature of human intelligence.

Before doing this, however, three important points must be noted. First, although it is common to present the debate in question in a dichotomous manner (as a conflict between the independent intelligences perspective and the *g* perspective), this dichotomy may not fully capture all the relevant theories about the structure of human intelligence. For example, some researchers have recently argued that *g* is an emergent and epiphenomenal property (rather than the cause) of various domain-general executive functions (Kovacs & Conway, 2016) or of interacting cognitive processes during development (van der Maas et al., 2006). It is not entirely clear whether, or to what extent, these theories differ from more standard conceptions of *g*. For example, Arthur Jensen, who is one of the most famous proponents of the *g* perspective, at times offer seemingly conflicting reflections on the nature of *g*, some of which closely parallel the emergentist perspective. (For more on this, see the discussion by van der Maas et al., 2006, p. 843). Moreover, there are some data indicating that emergentist theories of *g* may be wrong (Gignac, 2014) and, furthermore, they may also have a hard time explaining the often replicated finding that cognitive training has very little transfer, and almost no influence on *g* (Protzko, 2017; Sala & Gobet, 2017).

Second, proponents of the *g* perspective generally acknowledge both the conceptual and practical importance of specialized cognitive abilities (cf. footnote 2). Indeed, a lot of recent research is focused on *ability tilt*, which refers to within-subject differences in specialized cognitive abilities, such as verbal and mathematical ability. Important findings include that ability tilt predicts occupation and college majors (Coyle, 2019), and that there are sex differences in cognitive abilities (Wai et al., 2018).

Third, those who endorse the independent intelligences perspective today usually agree that factor analyzing a battery of cognitive tests results in a *g* factor that explains about half of the variance in IQ test performance; they just offer a different interpretation of it (cf. footnote 3). More specifically, the proponents of the independent intelligences research program recognize that there is a distinction between the positive manifold and *g*, and they argue that only the former phenomenon—i.e., the positive correlations of scores on different cognitive tasks—really exists in any empirically meaningful sense of the term. This position is arguably inspired by some of Gould's (1981) objections, such as that *g* should not be reified into a "thing". Although Gould's reification objection has been refuted (e.g., Bartholomew 2004; Bouchard, 2014),[5] the fact that there is a general agreement that the *g* factor (whatever its nature) explains approximately 50% of the variance in performance on well-constructed IQ tests shows that the aforementioned positions, presented in a

[5] Gould's dialectical opponents are not committed to the claim that *g* is a "thing" like, say, an organ. Rather, they endorse the proposition that it is a *construct* whose effects are observable at the level of manifest behavior, and that it reflects the existence of a general mental ability in the human mind.

somewhat dichotomous manner above, in some sense are less opposed to each other than they once were.

2 Theories of Independent Intelligences Constitute a Lakatosian Research Program

According to the philosopher of science Imre Lakatos, the proper unit of scientific evaluation is not individual theories or hypotheses, but rather a *sequence* of theories constituting a research program. Such a sequence of theories has the same *hard core*, which consists of a set of central theses that are made "irrefutable by methodological fiat"; they are irrefutable in the sense that the hard core does not in and of itself have any deducible empirical consequences. In order to derive testable predictions from the hard core, a theory has to rely on certain *auxiliary hypotheses* which allow for refutation of said theory, since the auxiliary hypotheses are (in contrast to the hard core) often considered falsified when evidence is presented that is inconsistent with the theory's predictions. Indeed, when a scientist working within a certain research program is presented with evidence that is inconsistent with the predictions of the theory that the scientist endorses, the natural (and rational) reaction is to retain the hard core but modify the auxiliary hypotheses in accordance with the "partially articulated set of suggestions" constituting the program's *positive heuristic* (Lakatos, 1978a, p. 50). That way, the scientist ends up endorsing a new theory, while nevertheless working within the same research program as before. This is how Lakatos aptly puts it:

> The negative heuristic of the programme forbids us to direct the *modus tollens* at this "hard core". Instead, we must use our ingenuity to articulate or even invent "auxiliary hypotheses", which form a *protective belt* around this core, and we must redirect the *modus tollens* to *these*. It is the protective belt of auxiliary hypotheses which has to bear the brunt of tests and get adjusted and re-adjusted, or even completely replaced, to defend the thus-hardened core. (Lakatos, 1978a, p. 48).

Given what has been said thus far, it is reasonable to think of theories of independent intelligences as a Lakatosian research program. These theories are indeed committed to the same hard core, which can be formulated as follows:

Hard core Human intelligence has a multidimensional structure, consisting of independent cognitive abilities. Moreover, human intelligence is not characterized by any general ability that is of greater practical importance, or that has greater predictive validity, than other, more specialized cognitive abilities.

Moreover, the theories differ insofar as they rely on different auxiliary hypotheses protecting the hard core. Consider some prominent examples. Edward Thorndike and Godfrey Thomson's sampling theory argues that *g* does not reflect the existence of a singular cognitive ability that influences one's performance on all cognitive tasks, but rather that it arises due to the overlap between different and uncorrelated neural "elements" (or cognitive abilities) (Thomson, 1951). The reason for the positive manifold is in other words not that human intelligence is characterized by a general cognitive ability, but instead that current IQ tests are not able measure any single

element or cognitive ability without also sampling other, uncorrelated abilities. The sampling theory thus acknowledges that factor analyses of IQ tests produce *g* as a *statistical construct*, but argues that *g* nevertheless is illusory in the sense that it does not adequately represent the myriad of uncorrelated intelligences that really exist in the human mind.

Another interesting theory is Joy Paul Guilford's (1967) structure-of-intellect (SOI) model, which states that there only exist specialized cognitive abilities; not only isn't there a *g* factor according to the SOI model, but it does not even allow for the existence of broad, second-order abilities. More specifically, the SOI model argues that there are three cognitive ability *facets* (not factors)—namely, *contents* (visual, auditory, symbolic, semantic, behavioral), *products* (units, classes, relations, systems, transformations, implications), and *operations* (cognition, memory, divergent production, convergent production, and evaluation)—each of which can be represented as one dimension of a rectangular prism containing 150 (5×6×5) cells. Each cell represents a type of intelligence that is uncorrelated with any of the other cells.

In his *Frames of Mind: The Theory of Multiple Intelligences* (2011), originally published in 1983, Howard Gardner develops what arguably is the most influential theory of independent intelligences—the multiple intelligences theory (MI). Originally, Garner argued that there were seven "relatively independent" kinds of intelligence: *Linguistic intelligence*, *logical-mathematical intelligence, musical intelligence, spatial intelligence, bodily-kinesthetic intelligence, interpersonal intelligence*, and *intrapersonal intelligence*. Later, he has added other kinds of intelligence to the list, such as *naturalistic intelligence* and *existential intelligence* (Gardner, 1999). For present purposes, it does not really matter what differentiates these intelligences and makes them unique. Rather, what's important is Gardner's contention that *g* is an artifact of the way in which IQ tests are constructed and, furthermore, that his seven (or nine) intelligences are conceived as modular, independent, and grounded in different biological subsystems.

The last example I want to discuss is Robert J. Sternberg's triarchic theory of intelligence. The triarchic theory argues that there are three different types of intelligence or components of information processing: *analytical/componential, creative/experiential*, and *practical/contextual* (Sternberg, 1985; Sternberg et al., 2000; Wagner, 1985). Whereas analytical (or componential) intelligence resembles *g* insofar as it is highly relevant to scholastic achievement and problem solving, the other types of intelligence involve different components of information processing and are typically unrelated to analytical ability. Notably, Sternberg argues that practical intelligence is not the same as *g*, and that it therefore is not unusual to find people that are "book smart" without being "street smart", or vice versa.

Now although these theories rely on different auxiliary hypotheses that differentiate them and make sure that they entail different empirical predictions, the auxiliary hypotheses all function to protect the same hard core of theoretical commitments—which means that they ultimately belong to the same research program. Continuing, the next section will make use of Lakatos's evaluative standard in order to determine the quality and productiveness of the independent intelligences research program.

3 Progress and Degeneration in Human Intelligence Research

According to Lakatos, the quality of a research program depends on a couple of properties which it may or may not have. A research program is considered *progressive* if it has the properties in question. However, if it does not have the properties, then it is considered *degenerating*.

Any progressive research program necessarily satisfies two important conditions: *theoretical progressiveness* and *empirical progressiveness*. A research program is theoretically progressive just in case "each new theory has some excess empirical content over its predecessor, that is, [. .] it predicts some novel hitherto unexpected fact" (Lakatos, 1978a, p. 33). To say that a sequence of theories constituting a research program is theoretically progressive means that the later theories entail novel predictions that are neither derivable from nor contained in earlier theories in the same program.[6] A research program is empirically progressive just in case "some of this excess empirical content is also corroborated, that is, [. .] each new theory leads to the discovery of some *new fact*" (Lakatos, 1978a, p. 34). To say that a sequence of theories constituting a research program is empirically progressive means that some of the novel predictions entailed by the program's later theories must be corroborated by empirical evidence. A research program is progressive if, and only if, it satisfies both of these conditions—otherwise it is degenerating (Lakatos, 1978a, p. 34).

Human intelligence research is characterized by a number of different research programs, and Lakatos's conceptual framework has been used several times before in order to evaluate some of them. In a paper written with encouragement from Lakatos (see Lakatos & Feyerabend 1999, pp. 348–349), Urbach (1974) relied on Lakatos's so-called "methodology" (i.e., his conceptual framework) in order to judge the relative quality of the different positions that were being debated in the aftermath of the publication of Jensen's (1969) famous article on IQ and scholastic achievement. Following Urbach, Rushton & Jensen (2005) used the technical notions of progress and degeneration (as defined above) in order to compare the merits and demerits of hereditarianism and environmentalism. Moreover, another example is provided by te Nijenhuis et al., (2017), who have argued that the Lakatosian anomalies engendered by testing of certain permutations of Spearman's hypothesis using the method of correlated vectors can be suggestive of new and progressive ways of developing relevant theory.[7] And another recent example is Egeland's (2022) evaluation of what he calls the "postindustrial selection research program", with the co-occurrence model

[6] Since I use Lakatos's philosophy of science as my point of departure, I will simply assume that this conception of theoretical progress is adequate. However, as an anonymous referee helpfully noted, theoretical progress can plausibly be made by offering novel interpretations of already existing data, in which case the contributions of (e.g.) the sampling theory (further discussed below) can be seen in a more positive light.

[7] The authors used Jensen's method of correlated vectors, which looks for correlations between the vector of intelligence subtests' *g* loadings and the vector of the subtests' correlations with another variable of interest. In the case of testing of Spearman's hypothesis, this variable has to do with group differences, as said hypothesis claims that group differences are most concentrated on the subtests with the highest *g* loadings. te Nijenhuis et al., (2017) found certain anomalies, in the sense that there are group comparisons for which the data indicate that Spearman's hypothesis is not true. However, when they tested the hypothesis on verbal and performance subtests separately, many of the comparisons corroborated the

as its latest and most sophisticated constituent theory, as scientifically progressive. Continuing, for the remainder of this section it will be argued that the independent intelligences research program is degenerating, since it has not lead "to the discovery of hitherto unknown novel facts" (Lakatos, 1978b).

Consider first Thorndike and Thomson's sampling theory, which argues that *g* does not reflect the existence of a singular cognitive ability that influences one's performance on all cognitive tasks, but rather that it arises due to the overlap between different and uncorrelated neural "elements" (or cognitive abilities). The sampling theory's greatest weakness is that it is not theoretically progressive; it does not entail any novel prediction that is not contained in, or derivable from, earlier theories belonging to the same research program. More specifically, the sampling theory successfully demonstrates that the positive manifold does not by itself *entail* the existence of *g* as a general cognitive ability, since the existence of all-positive correlations between different cognitive tests is consistent with the claim that there are multiple independent cognitive abilities that invariably are sampled together in the tests, but the theory itself does not provide any new empirical content. As one psychometrician has put it:

The sampling theory hardly qualifies as a true theory, for it does not make any assertion to which evidence is relevant. Perhaps the large number of adherents to this view is due to the fact that no one has offered evidence against it. But until the view is defined more sharply, one cannot even conceive of the possibility of contrary evidence, nor, for that matter, confirmatory evidence. A statement about the human mind which can be neither supported nor refuted by any facts, known or conceivable, is certainly useless (Loevinger, 1951, pp. 594–595).

Furthermore, the sampling theory also does not satisfy the condition of empirical progressiveness. Not just does it not provide novel predictions, at least some of which are corroborated by the empirical evidence, but it also does not cohere with all the evidence that we already have. For example, given that the sampling theory were true, one would not expect that cognitive tests that appear to sample quite different neural "elements"—such as tests with radically different culture loadings—to correlate as highly with each other as they in fact do. Several examples to this effect are provided by Jensen (1998, pp. 117–122). (See also Eysenck 1987, for more on the empirical problems with the sampling theory.)

Next, we have Guilford's SOI model. The SOI model claims that there are 150 specialized cognitive abilities, all of which should be measurable and uncorrelated. Although the model has some theoretical oddities (if not outright problems)—such as determining the number of cognitive abilities on the basis of the ways in which certain postulated cognitive ability facets are thought to combine—it is without a doubt theoretically progressive. As Lakatos would put it, the model has "excess empirical content over its predecessor". However, it is equally clear that the SOI model is not empirically progressive. When Guildford's U.S. Air Force personnel data was reanalyzed and corrections were made for attenuation and range restriction, the correlations between his tests had a mean value of +0.45, and all the correlations were positive (Alliger, 1988; cf. Carroll, 1993, pp. 57–60).

hypothesis, indicating that whether or not it is true may depend on the verbal/performance ability profiles of the groups compared.

But what about Gardner's famous MI theory? Gardner's theory that there are seven (or nine) "relatively independent" intelligences is also theoretically progressive, since it predicts that the aforementioned intelligences should be measurable, uncorrelated, and have separate biological foundations. Nevertheless, it should be mentioned that it also has several theoretical problems: It is too vague, since it does not specify *how* independent the intelligences are. Are they only weakly correlated or not correlated at all, or are they perhaps even negatively correlated? Gardner does not say. Moreover, he does not specify how his intelligences can work together when performing complex tasks that require the individual to use of more than one of them at the same time. The theory has also been alleged to rely on circular reasoning, and it does not offer adequate concrete suggestions for how it can be tested. Concerning this latter point, testing the theory in accordance with Gardner's suggestions would either be too time and resource consuming for practical purposes, or result in relatively unreliable data with little or no practical value. (For helpful and more detailed expostulations of the theoretical problems facing Gardner's theory, see: Brody 1992, p. 40; Hunt 2011; Jensen, 1998, pp. 128–132; Warne, 2020, pp. 57–59).

Moreover, the MI theory has grave empirical problems, the biggest of which is that systematic and well-designed studies attempting to determine whether there exist multiple intelligences invariably discover a *g* factor that explains the positive correlations between the tests (e.g., Castejon et al., 2010; Pyryt, 2000; Visser et al., 2006).[8] Other serious problems include the fact that Gardner (2011) appears to have a rather strong confirmation bias, choosing to favor and focus on evidence that appears to confirm his theory, while ignoring or simply dismissing contradicting evidence (e.g., Bouchard Jr, 1984; Messick, 1992; Scarr, 1985). For example, he occasionally outright rejects not just results that conflict with the MI theory, but even the gathering of evidence that might threaten its perceived veracity as "incendiary" or "pseudoscience" (e.g., Gardner 2006, p. 239).[9] A related issue concerns Gardner's reliance on anecdotal data on outliers and eminent individuals, rather than representative samples of subjects taking tests that are supposed to measure his different intelligences. By its very nature, anecdotal evidence has extremely limited generalizability and cannot be used to provide empirical support to theories about the psychological or behavioral structure of all (or most) people's abilities. Moreover, Gardner has reportedly estimated that one would need an IQ of at least 120 to be included in his list of eminent individuals (Jensen, 1998, p. 128). But if high IQ is required for intellectual success or eminence, any plausible explanation of why (e.g.) Picasso or T. S. Elliot achieved such a high degree of eminence must reference their high level of *g*, since most of the predictive and explanatory power of IQ comes from *g* (Ackerman et al.,

[8] It must be noted that there is some evidence that Gardner's intelligences have "distinct" and "coherent" neural correlates, which some have interpreted as evidence for his theory (Shearer & Karanian, 2017). However, at the level of observable behavior, and in particular of test-performance, it appears that there generally is a positive manifold among Gardner's multiple intelligences that gives rise to a higher-order general ability factor. Moreover, as already mentioned in the introduction, there is not at the moment any consensus as to what *g* fundamentally is at, say, the biological level, and some proponents of the *g* perspective have voiced the opinion that it may be the case that it does not represent any singular feature of the brain.

[9] For a detailed discussion of this, see Cofnas (2016, pp. 483–486).

2013; Ganzach & Patel, 2018; Kell et al., 2013; Ree & Carretta, 2022; Zaboski et al., 2018). All of this means that the MI theory is not empirically progressive.

Lastly, we have Sternberg's triarchic theory of intelligence, which argues that there are practical and creative intelligences, that they are different from *g*, and that they are just as important for achieving important real-life outcomes. Moreover, it should be noted that Sternberg (1982) does not in any way deny either the existence or importance of *g*; he just believes that there are other, equally (if not more) important intelligences. The triarchic theory is theoretically progressive since it offers novel predictions. For example, it predicts that practical and creative intelligence do not correlate with *g*, and that these intelligences should be just as important as *g* for achieving one's goals.

However, one problem with Sternberg's theory is that he appears to have inconsistent attitudes toward the claim that practical intelligence is context-dependent. Sometimes he (1985) argues that the ability to learn tacit, non-academic knowledge is context-invariant, meaning that the non-academic, non-*g* skills needed to become successful in one environment will enable one to achieve success in other environments. However, at other times Sternberg seems to fall back on the commonsense position that high practical ability in one context does not guarantee high practical ability in another. For example, a test of practical intelligence for Kenyan children involved a question about plausible causes of a regular stomachache, and the correct answers included that the person with the stomachache "is affected by the evil eye (*sihoho*)" (Sternberg et al., 2001, p. 408). Now it is not just doubtful that believing in superstitions that might be dangerous to one's health is helpful for achieving one's goals in rural Kenyan villages, it is pretty much certain that it is not going to help you in a modern Western environment.[10] Sternberg's inconsistent attitudes toward the context-dependent nature of high practical ability manifests what one commentator has called a "heads-I-win-tails-you-lose" strategy (Gottfredson, 2003).

Moreover, just as with Guilford and Gardner's theories, the triarchic theory's biggest problem is that it is not empirically progressive. Indeed, when Sternberg's data are factor-analyzed, his three intelligences are not just found be correlated and, hence, produce a *g* factor (Brody, 2003; Chooi et al., 2014; Hunt, 2008; Jukes et al., 2006; Messick, 1992; Stemler, Chamvu, et al., 2009; Stemler, Grigorenko, et al., 2009), but no one (at least to the present author's knowledge) has been able to demonstrate that this general factor *is not* more important than either practical or creative ability alone. After all, the proposition that it is *g* that really matters for achieving positive outcomes in different environments coheres more with the available evidence (Ackerman et al., 2013; Ganzach & Patel, 2018; Kell et al., 2013; Ree & Carretta, 2022; Zaboski et al., 2018).

[10] *Cf.* Rindermann et al., (2014), who found that epistemic rationality (in the Piagetian sense of the term) was associated with general intelligence in a sample of German and Nigerian participants. This seems to cohere with the findings of Sternberg, since scoring high on epistemic rationality required that one did *not* respond in a way that is indicative of superstitious thinking, even though both constructs were measured using similar items. The upshot is that high practical intelligence (which, due to different ways of scoring, becomes the same as low epistemic rationality) does not translate across contexts, as it can be reflective of superstitious thinking patterns.

In sum, none of the most prominent theories of different and independent types of intelligence are both theoretically and empirically progressive. What is remarkable about the independent intelligences research program is not just that it isn't the case that all of the theoretical developments within the program—the so-called *problem shifts* (Lakatos, 1978a, p. 37)—are theoretically and empirically progressive, which must be so if the program is to be considered progressive in general, but that *none* of the theoretical developments within the program appear to be theoretically and empirically progressive. The independent intelligences research program must therefore be considered degenerating.

4 From Psychological Muck to Philosophical Gold: Illustrating some Problems with Lakatos's Conceptual Framework

When judging in accordance with the Lakatosian standard, whereby the quality of a sequence of scientific theories sharing the same hard core is a function of its theoretical and empirical progressiveness, the independent intelligences research program is clearly degenerating. However, despite its flaws as a scientific view of the nature of human intelligence, the independent intelligences research program is nevertheless philosophically useful since it illustrates some of the problems with Lakatos's conceptual framework. Although Lakatos's methodology has a lot going for it and certainly constitutes an improvement over earlier falsificationist philosophies, Musgrave (1976) has plausibly argued that it faces three particularly pressing problems (cf. Laudan, 1977, pp. 77–78). Using Lakatos's own examples—namely, Newton, Prout and Bohr's research programs—he shows that Lakatos's conceptions of the negative heuristic, the positive heuristic, and the relationship between scientific appraisal and advice all are vulnerable to objections. Let's consider the negative heuristic first.

Lakatos tells us that the hard core of a research program is rationally made "irrefutable by methodological fiat", and that the negative heuristic commands us to direct the *modus tollens* at the auxiliary hypotheses instead. However, as Musgrave (1976, pp. 459–467) shows by focusing on Lakatos's own examples, it is not true that scientists always consider the hard core immune to empirical refutation, nor is it the case that they always should do so. Moreover, this is a point that the independent intelligences research program can help us illustrate. Although I don't know of anyone who has attempted to modify or alter its hard core, it would clearly be irrational to retain it regardless of the number of anomalies that accumulate with observation or experimentation.

When Gardner (2011, p. xxxix) outright dismisses evidence that threatens the hard core, or when he states that

> even if at the end of the day, the bad guys [i.e., those who work within the alternative, *g*-centered research program] turn out to be more correct scientifically than I am, life is short. And we have to make choices about how we spend our time, and that's where I think the multiple intelligences way of thinking about things will continue to be useful, even if the scientific evidence isn't supportive (Gardner, 2009, 0:45:11 – 0:45:32).

he has rightly been criticized for having an overly dogmatic attitude toward both the hard core and the auxiliary hypotheses of the MI theory (Cofnas, 2016, pp. 483–486; Warne, 2020, pp. 52–61). And the reason is that retaining the hard core at all costs, or making it "irrefutable by methodological fiat", is not always rational when anomalies abound and there is no clear way forward for saving the research program.

This brings us to Lakatos's second problem, which is that the positive heuristic cannot always anticipate empirical refutations and provide guidelines for how the auxiliary hypotheses (i.e., the protective belt) are to be modified in response to them (Musgrave, 1976, pp. 467–473). According to Lakatos, the positive heuristic "consists of a partially articulated set of suggestions or hints on how to change, develop the 'refutable variants' of the research programme, how to modify, sophisticate the 'refutable' protective belt", and it "saves the scientist from becoming confused by the ocean of anomalies [… since] their existence is fully expected" (Lakatos, 1978a, pp. 50–51). However, when studying actual research programs, we find that the positive heuristic often is developed over time along with other parts of the program, and that it therefore cannot always provide guidelines for handling anomalies or empirical refutations before they present themselves. Indeed, the independent intelligences research program is a case in point, as its positive heuristic has not included good enough "hints" to develop new auxiliary hypotheses that enable the research program to "digest" the *g* factor that invariably is produced when cognitive tests are submitted to factor analysis. Not just that, as we have seen above, scientists working within the independent intelligences research program do not always "expect" that their independent intelligences will correlate, even though they pretty much always do.

Lastly, we have the third problem facing Lakatos's methodology. The problem is that it is not clear what the relationship between scientific appraisal and advice is. We know that a research program is of high quality when it is theoretically and empirically progressive, and that it is considered degenerating when it does not have these properties. But what should a scientist do with this information? Should, for example, the scientist working within a degenerating research program abandon it in favor of a progressive one? As Musgrave (1976, pp. 473–483) explains, Lakatos argues that a research program will only be abandoned when there exists an alternative program for the scientist to work on—regardless of whether, or to what extent, the program is confronted with anomalies. Moreover, Lakatos sometimes claims that his methodology does not issue any advice to scientists concerning which research program they should work within, other than that they should be *honest* about the relative quality of the various programs that exist (Lakatos, 1971b, pp. 174, 178). However, at other times Lakatos seems to suggest that there isn't a clear distinction between appraisal and advice, and that resources, time, and energy should be focused on progressive research programs (unless there only exist degenerating ones) (Lakatos, 1968, p. 343; 1971a, p. 100; 1971b, p. 174; 1978a, pp. 89–90). So, in other words, the problem is that it is not clear what scientists should do when presented with relevant information about the relative merits and demerits of the research programs on the market.

Moreover, this is an issue that intelligence researchers cannot remain agnostic about, and it is especially relevant when it comes to the independent intelligences research program. Given that said program is degenerating—as it indeed has been argued above—should its proponents continue their work on it, or should they per-

haps abandon it in favor of the *g*-centered research program? There does not appear to be a forthcoming answer. On the one hand, it does not seem reasonable that the scientific community should devote just as much energy to the independent intelligences research program as its more meritorious rival. But, on the other hand, one would not want everyone working within the independent intelligences research program to abandon it—after all, there is never any *a priori* guarantee that fortunes won't change, or that what has worked in the past will continue to do so in the future. A reasonable compromise might be that the scientific community should devote most, but not all, of its resources and energy to progressive research programs (cf. Musgrave, 1976).

5 Conclusion

This paper has argued that theories of different and independent types of intelligence constitute a degenerating Lakatosian research program. However, despite its scientific weaknesses, the program has philosophical value insofar as it provides an illustrative example of the biggest problems facing Lakatos's methodology. Although no final conclusion is reached regarding what the way forward should be, it is recommended that intelligence researchers, and the wider society too, should give priority to progressive, rather than degenerating, research programs—but with conscious awareness of the fact that the quality of any such program may change with time.

Funding Open access funding provided by University of Agder

Declarations

Statements and declarations The author declares that there are no conflicts of interest.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Ackerman, P. L., Kanfer, R., & Calderwood, C. (2013). High school Advanced Placement and student performance in college: STEM majors, non-STEM majors, and gender differences. *Teachers College Record*, *114*, 1–43

Alliger, G. M. (1988). Do zero correlations really exist among measures of different intellectual abilities? *Educational and Psychological Measurement*, *48*, 275–280. https://doi.org/https://doi.org/10.1177%2F0013164488482001

Bartholomew, D. J. (2004). *Measuring intelligence: Facts and fallacies*. Cambridge University Press

Bouchard, T. J. Jr. (1984). Review of *Frames of mind: The theory of multiple intelligences*. *American Journal of Orthopsychiatry*, *54*(3), 506–508. https://doi.org/10.1111/j.1939-0025.1984.tb01522.x

Bouchard, T. J. Jr. (2014). Genes, evolution and intelligence. *Behavior Genetics*, *44*(6), 549–577. https://doi.org/10.1007/s10519-014-9646-x

Brody, N. (1992). *Intelligence* (2nd ed.). Academic Press, Inc

Brody, N. (2003). Construct validation of the Sternberg triarchic abilities test: Comment and reanalysis. *Intelligence*, *31*(4), 319–329. https://doi.org/10.1016/S0160-2896(01)00087-3

Carroll, J. B. (1993). *Human Cognitive Abilities: A Survey of Factor-Analytic Literature*. Cambridge University Press

Castejon, J. L., Perez, A. M., & Gilar, R. (2010). Confirmatory factor analysis of project spectrum activities. A second-order *g* factor or multiple intelligences? *Intelligence*, *38*(5), 481–496. https://doi.org/10.1016/j.intell.2010.07.002

Chooi, W. T., Long, H. E., & Thompson, L. A. (2014). The Sternberg Triarchic Abilities Test (Level-H) is a Measure of *g*. *Journal of Intelligence*, *2*, 56–67

Cofnas, N. (2016). Science is not always "self-correcting": Fact–value conflation and the study of intelligence. *Foundations of Science*, *21*(3), 477–492

Coyle, T. R. (2019). Tech tilt predicts jobs, college majors, and specific abilities: Support for investment theories. *Intelligence*, *75*, 33–40

Egeland, J. (2022). The ups and downs of intelligence: The co-occurrence model and its associated research program. *Intelligence*, *92*, 101643. https://doi.org/10.1016/j.intell.2022.101643

Eysenck, H. J. (1987). Thomson's "bonds" or Spearman's "energy": Sixty years on. *Mankind Quarterly*, *27*(3), 259–274

Flynn, J. R. (2012). *Intelligence and human progress: The story of what was hidden in our genes*. Elsevier

Flynn, J. R. (2013). The "Flynn Effect" and Flynn's paradox. *Intelligence*, *41*(6), 851–857

Ganzach, Y., & Patel, P. C. (2018). Wages, mental abilities and assessments in large scale international surveys: Still not much more than g. *Intelligence*, *69*, 1–7

Gardner, H. (1999). *Intelligence Reframed: Multiple Intelligences for the 21st Century* (New edition ed.). Basic Books

Gardner, H. (2006). *The Development and Education of the Mind: The Selected Works of Howard Gardner*. Routledge

Gardner, H. (2009). *Intelligence: It's not just IQ*. Rockefeller University. Retrieved from https://bit.ly/2qQR6J1

Gardner, H. (2011). *Frames of Mind: The Theory of Multiple Intelligences*. Basic Books

Gignac, G. (2014). Dynamic mutualism versus *g* factor theory: An empirical test. *Intelligence*, *42*, 89–97. https://doi.org/10.1016/j.intell.2013.11.004

Gottfredson, L. S. (2003). Dissecting practical intelligence theory: Its claims and evidence. *Intelligence*, *31*(4), 343–397. https://doi.org/10.1016/S0160-2896(02)00085-5

Gould, S. J. (1981). *The mismeasure of man*. W. W. Norton

Griggs, R. A., Proctor, D. L., & Cook, S. M. (2004). The most frequently cited books in introductory texts. *Teaching of Psychology*, *31*(2), 113–116

Guilford, J. P. (1967). *The nature of human intelligence*. McGraw-Hill

Haier, R. J. (2017). *The neuroscience of intelligence*. Cambridge University Press

Hunt, E. (2008). Applying the theory of successful intelligence to education -The good, the dad, and the ogre: Commentary on Sternberg et al. (2008). *Perspectives on Psychological Science*, *3*(6), 509–515. https://doi.org/10.1111/j.1745-6924.2008.00094.x

Hunt, E. B. (2011). *Human intelligence*. Cambridge University Press

Jensen, A. R. (1969). How much can we boost IQ and scholastic achievement? *Harvard Educational Review*, *39*(1), 1–123. https://doi.org/10.17763/haer.39.1.l3u15956627424k7

Jensen, A. R. (1998). *The g Factor: The Science of Mental Ability*. Praeger

Jukes, M. C., Pinder, M., Grigorenko, E. L., Smith, H. B., Walraven, G., Bariau, E. M., Sternberg, R. J., Drake, L. J., Milligan, P., Cheung, Y. B., Greenwood, B. M., & Bundy, D. A. (2006). Long-term impact of malaria chemoprophylaxis on cognitive abilities and educational attainment: follow-up of a controlled trial. *Plos Clinical Trials*, *1*(4), e19. https://doi.org/10.1371/journal.pctr.0010019

Kell, H. J., Lubinski, D., Benbow, C. P., & Steiger, J. H. (2013). Creativity and technical innovation: Spatial ability's unique role. *Psychological Science*, *24*, 1831–1836

Klein, P. D. (1997). Multiplying the problems of intelligence by eight: A critique of Gardner's theory. *Canadian Journal of Education*, *22*(4), 377–394. https://doi.org/10.2307/1585790

Kovacs, K., & Conway, A. R. A. (2016). Process overlap theory: A unified account of the general factor of intelligence. *Psychological Inquiry*, *27*(3), 151–177. https://doi.org/10.1080/1047840X.2016.1153946

Lakatos, I. (1968). Changes in the Problem of Inductive Logic. In I. Lakatos (Ed.), *The Problem of Inductive Logic* (pp. 315–417). North-Holland

Lakatos, I. (1971a). History of Science and Its Rational Reconstructions. In R. S. C. R. C. Buck (Ed.), *P.S.A. 1970, Boston Studies in the Philosophy of Science* (Vol. 8, pp. 91–136). Reidel

Lakatos, I. (1971b). Replies to critics. In R. S. C. R. C. Buck (Ed.), *P.S.A. 1970, Boston Studies in the Philosophy of Science* (Vol. 8, pp. 174–182). Reidel

Lakatos, I. (1978a). Falsification and the methodology of scientific research programmes. In J. W. G. Currie (Ed.), *The Methodology of Scientific Research Programmes. Philosophical Papers: Volume 1* (pp. 8–101). Cambridge University Press

Lakatos, I. (1978b). Science and pseudoscience. In G. C. J. Worrall (Ed.), *The Methodology of Scientific Research Programmes. Philosophical Papers: Volume 1* (pp. 1–7). Cambridge University Press

Lakatos, I., & Feyerabend, P. (1999). *For and Against Method: Including Lakatos's Lectures on Scientific Method and the Lakatos-Feyerabend Correspondence*. The University of Chicago Press

Laudan, L. (1977). *Progress and its problems: toward a theory of scientific growth*. University of California Press

Loevinger, J. (1951). Intelligence. In H. Helson (Ed.), *Theoretical Foundations of Psychology* (pp. 557–601). Van Nostrand

Messick, S. (1992). Multiple intelligences or multilevel intelligence? Selective emphasis on distinctive properties of hierarchy: On Gardner's *Frames of Mind* and Sternberg's *Beyond IQ* in the context of theory and research on the structure of human abilities. *Psychological Inquiry*, *3*, 365–384

Musgrave, A. (1976). Method or madness?. In R. S. Cohen, P. K. Feyerabend, & M. W. Wartofsky (Eds.), *Essays in Memory of Imre Lakatos* (39 vol., pp. 457–492). Springer. Boston Studies in the Philosophy of Science

Panizzon, M. S., Vuoksimaa, E., Spoon, K. M., Jacobson, K. C., Lyons, M. J., Franz, C. E., Xian, H., Vasilopoulos, T., & Kremen, W. S. (2014). Genetic and Environmental Influences of General Cognitive Ability: Is *g* a valid latent construct? *Intelligence*, *43*, 65–76. https://doi.org/10.1016/j.intell.2014.01.008

Protzko, J. (2017). Effects of cognitive training on the structure of intelligence. *Psychonomic Bulletin & Review*, *24*(4), 1022–1031. https://doi.org/10.3758/s13423-016-1196-1

Pyryt, M. C. (2000). Finding "*g*": Easy viewing through higher order factor analysis. *Gifted Child Quarterly*, *44*(3), 190–192. https://doi.org/10.1177/001698620004400305

Ree, M. J., & Carretta, T. R. (2022). Thirty years of research on general and specific abilities: Still not much more than *g*. *Intelligence*, *91*, 101617. https://doi.org/10.1016/j.intell.2021.101617

Reeve, C. L., & Charles, J. E. (2008). Survey of opinions on the primacy of g and social consequences of ability testing: A comparison of expert and non-expert views. *Intelligence*, *36*(6), 681–688. https://doi.org/10.1016/j.intell.2008.03.007

Rindermann, H., & Becker, D. (2018). FLynn-effect and economic growth: Do national increases in intelligence lead to increases in GDP? *Intelligence*, *69*, 87–93

Rindermann, H., Becker, D., & Coyle, T. R. (2020). Survey of expert opinion on intelligence: Intelligence research, experts' background, controversial issues, and the media. *Intelligence*, *70*, 399. https://doi.org/10.1016/j.intell.2019.101406

Rindermann, H., Falkenhayn, L., & Baumeister, A. (2014). Cognitive ability and epistemic rationality: A study in Nigeria and Germany. *Intelligence*, *47*, 23–33. https://doi.org/10.1016/j.intell.2014.08.006

Rushton, J. P., & Jensen, A. R. (2005). Thirty Years of Research of Race Differences in Cognitive Ability. *Psychology Public Policy and Law*, *11*, 235–294

Sala, G., & Gobet, F. (2017). Does Far Transfer Exist? Negative Evidence From Chess, Music, and Working Memory Training. *Current Directions in Psychological Science*, *26*(6), 515–520. https://doi.org/10.1177/0963721417712760

Scarr, S. (1985). An author's frame of mind: Review of Frames of Mind: The Theory of Multiple Intelligences by Howard Gardner, Basic Books (1984). *New Ideas in Psychology*, *3*, 95–100

Schroth, S. T., & Helfer, J. A. (2009). Practitioner' Conceptions of Academic Talent and Giftedness: Essential Factors in Deciding Classroom and School Composition. *Journal of Advanced Academics*, *20*(3), 384–403

Shearer, C. B., & Karanian, J. M. (2017). The neuroscience of intelligence: Empirical support for the theory of multiple intelligences? *Trends in Neuroscience and Education*, *6*, 211–223. https://doi.org/10.1016/j.tine.2017.02.002

Snyderman, M., & Rothman, S. (1988). *The IQ controversy, the media and public policy*. Transaction

Spearman, C. (1904). "General intelligence": objectively determined and measured. *The American Journal of Psychology*, *15*(2), 201–293

Spearman, C. E. (1927). *The Abilities of Man*. Macmillan

Stemler, S. E., Chamvu, F., Chart, H., Jarvin, L., Jere, J., Hart, L., Kaani, B., Kalima, K., Kwiatkowski, J., Mambwe, A., Kasonde-N'gandu, S., Newman, T., Serpell, R., Sparrow, S., Sternberg, R. J., & Grigorenko, E. L. (2009). Assessing competencies in reading and mathematics in Zambian children. In E. L. Grigorenko (Ed.), *Multicultural Psychoeducational Assessment* (pp. 157–185). Springer Publishing Co

Stemler, S. E., Grigorenko, E. L., Jarvin, L., & Sternberg, R. J. (2009). Using the theory of successful intelligence as a basis for augmenting AP exams in psychology and statistics. In E. L. Grigorenko (Ed.), *The essential Sternberg: Essays on intelligence, psychology, and education* (pp. 235–270). Springer Publishing Co

Sternberg, R. J. (1985). *Beyond IQ: A Triarchic Theory of Human Intelligence*. Cambridge University Press

Sternberg, R. J., & Gardner, M. K. (1982). A componential interpretation of the general factor in human intelligence. In H. J. Eysenck (Ed.), *A Model for Intelligence* (pp. 231–254). Springer-Verlag

Sternberg, R. J., Forsythe, G. B., Hedlund, J., Horvath, J. A., Wagner, R. K., Williams, W. M., Snook, S. A., & Grigorenko, E. (2000). *Practical intelligence in Everyday Life*. Cambridge university press

Sternberg, R. J., Nokes, C., Geissler, P. W., Prince, R., Okatcha, F., Bundy, D. A., & Grigorenko, E. L. (2001). The relationship between academic and practical intelligence: A case study in Kenya. *Intelligence*, *29*(5), 401–418. https://doi.org/10.1016/S0160-2896(01)00065-4

te Nijenhuis, J., van den Hoek, M., Metzen, D., & David, H. (2017). Spearman's hypothes is not supported? Three meta-analyses of Black and White prisoners, Northeast Asians, and Arabs and Jews. *Personality & Individual Differences*, *117*, 52–59

Thomson, G. (1951). *The Factor Analysis of Human Ability* (5th ed.). University of London Press

Urbach, P. F. (1974). Progress and Degeneration in the 'IQ Debate' (I)*. *The British Journal for the Philosophy of Science*, *25*, 99–135

van der Maas, H. L., Dolan, C. V., Grasman, R. P., Wicherts, J. M., Huizenga, H. M., & Raijmakers, M. E. (2006). A dynamical model of general intelligence: the positive manifold of intelligence by mutualism. *Psychological Review*, *113*(4), 842–861. https://doi.org/10.1037/0033-295x.113.4.842

Visser, B. A., Ashton, M. C., & Vernon, P. A. (2006). Beyond *g*: Putting multiple intelligences theory to the test. *Intelligence*, *34*(5), 487–502. https://doi.org/10.1016/j.intell.2006.02.004

Wagner, R. K., & Sternberg, R. J. (1985). Practical intelligence in real-world pursuits. *Journal of Personality and Social Psychology*, *49*, 436–458

Wai, J., Hodges, J., & Makel, M. C. Sex differences in ability tilt in the right tail of cognitive abilities: A 35-year examination.Intelligence, *67*,76–83

Warne, R. T. (2020). *In the Know: Debunking 35 Myths about Human Intelligence*. Cambridge University Press

Warne, R. T., Astle, M. C., & Hill, J. C. (2018). What do undergraduates learn about human intelligence? An analysis of introductory psychology textbooks. *Archives of Scientific Psychology*, *6*(1), 32–50. https://doi.org/10.1037/arc0000038

Warne, R. T., & Burton, J. Z. (2020). Beliefs about human intelligence in a sample of teachers and nonteachers. *Journal for the Education of the Gifted*, *42*, 143–166. https://doi.org/https://doi.org/10.1177%2F0162353220912010

Woodley, M. A. (2012). The social and scientific temporal correlates of genotypic intelligence and the Flynn effect. *Intelligence*, *40*(2), 189–204

Zaboski, B. A., Kranzler, J. H., & Gage, N. A. (2018). Meta-analysis of the relationship between academic achievement and broad abilities of the Cattell-Horn-Carroll theory. *Journal of School Psychology*, *71*, 42–56