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COMMENT

Why *g* Is Not an Adaptation: A Comment on Kanazawa (2004)

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In S. Kanazawa's (2004) evolutionary theory of general intelligence (*g*), *g* is presented as a species-typical information-processing mechanism. This conceptualization of *g* departs radically from the accepted conceptualization of *g* as a source of individual differences that is manifest in the positive manifold. Kanazawa's theory is thus problematic in the sense that it concerns a purely hypothetical, and empirically unsupported, conceptualization of *g*. The authors argue that an evolutionary account of *g* should address it as a source of individual differences—that is, in a manner that is consistent with the empirical support for *g*.

Keywords: positive manifold, general intelligence, evolutionary psychology, module, latent variable theory

Kanazawa (2004) offered an evolutionary psychological account of general intelligence (*g*). In this account, *g* is viewed as a domain-specific adaptation, which is limited to the domain of novelty. Thus, *g* comes into play when one is confronted with a novel problem, just as the ability of blood to clot is activated by damage to blood vessels. Although human beings' environment of evolutionary adaptedness (EEA) was supposedly characterized by a high degree of stability, novel problems did present themselves occasionally. It is the successful resolution of such problems that required *g*. Because *g* conferred survival value in solving these problems, it became an adaptation specific to the domain of novelty within the EEA. According to Kanazawa, the reason that *g* is universally important in present societies is that these societies are novel in an evolutionary sense.

The aim of the present comment is to show that Kanazawa's thesis is theoretically flawed. The reason for this is that Kanazawa's theory concerns a species-typical trait that requires the operation of *g* at the level of the individual. However, *g* is not a hypothesized mechanism within the human being, but a hypothetical source of differences between human beings. Even if some psychological module dedicated to solving evolutionary novel problems existed, logically, it would not be identical to *g*; hence, Kanazawa's theory is not about *g*. On the other hand, if there were such a thing as an evolutionary account of *g*, then this account should explain how the relevant structures of individual differences evolved. Because Kanazawa's theory can only "explain the evolution of species-typical general intelligence, not individual differences in *g*" (Kanazawa, 2004, p. 521), it is no such theory. Thus, if Kanazawa's theory were correct, then it would not be about *g*, and if it were about *g*, then it would not be correct. As a result of this theoretical mismatch, the empirical data that Kanazawa cites do not bear on his hypothesis, let alone yield support for it.

Evolutionary Psychology and Kanazawa's *g*

Evolutionary psychologists seek to characterize as evolutionary adaptations the universal, species-typical architecture of the information-processing mechanisms that generate psychologically relevant behavior (Buss, 1999; Cosmides & Tooby, 2002; Crawford, 1998; Rauscher & Scher, 2003; Tooby & Cosmides, 1992). These information-processing mechanisms are supposed to be modular and domain specific. They evolved in human beings' EEA during the Pleistocene because they increased inclusive fitness by providing the solution to specific adaptive problems. The information-processing modules are species typical because they are the outcome of normal psychological development. In this sense, they are like physical characteristics, such as internal organs: All normal human beings are endowed with them, and they perform important specific tasks. Because the actual physical instantiation of most modules is unknown, we cannot yet associate information-processing models with physical characteristics. We can, however, observe species-typical behavior, posit a module as a hypothetical construct, explain the observed behavior in terms of an evolutionary adaptation, and derive a set of predictions concerning other instances of behavior, so that the theory can be tested. This is what evolutionary psychologists attempt to do.

Kanazawa's idea of *g* is that it is exactly such a hypothetical module.[1] Thus, next to Cosmides' (1989) cheater detection mod-

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[1] Kanazawa used the term *evolved psychological mechanism* to refer to his conceptualization of *g*. An evolved psychological mechanism is "roughly synonymous with an *adaptation* or *module*" (Kanazawa, 2004, p. 512). We use the shorter term *module* for ease of exposition.

ule, Pinker's (1994) language acquisition device, and Daly and Wilson's (1987) discriminative parental solicitude sits Kanazawa's *g* module. What does this module do? It solves problems that are evolutionarily novel and nonrecurrent. Several examples are provided (Kanazawa, 2004, p. 514):

> The lightning has struck the tree near the camp and set it on fire. The fire is now spreading to the dry underbrush. What should I do? How could I stop the spread of the fire?
>
> A flash flood has caused the river to swell to several times its normal width, and I am trapped on one side of it while my entire band is on the other side. It is imperative that I rejoin them soon. How could I cross the rapid river?

To solve these problems requires thinking and reasoning. It is here, Kanazawa argued, that the module *g* is of decisive importance. As a result, those among our ancestors who did possess *g* had an evolutionary advantage over those who did not. This is the reason that in the evolutionary novel environments of the present, *g* is so important.

In light of the literature on *g*, these examples are curious. No theorist on *g* has ever suggested, or even hypothesized, that *g* could be responsible for such behaviors as crossing rivers or extinguishing fires. The construct *g* has been proposed as an explanation for the empirical phenomenon that interindividual differences on distinct intelligence tests are positively correlated: On average, people who score highly on verbal tests also score highly on spatial and numerical tests. This empirical phenomenon is called the positive manifold. The idea of *g* is that the positive manifold exists because individual differences on verbal, spatial, and numerical tests all originate from individual differences on one single latent dimension, and this latent dimension is called *g*. The evidence for the existence of *g* as a source of individual differences, or, equivalently, as a source of variance, is established by means of factor analysis of a wide variety of IQ test scores, in which *g* is identified with the common factor at the apex of a hierarchical common factor model (Carroll, 1993; Gustafsson, 1988; Jensen, 1998, 2002). Thus, *g* is "general" in the sense that it underlies, to varying extents, differences in performance on all cognitive tests. This, however, does not mean or imply that it is a unitary module that operates within individual persons.

Deary (2002, p. 153) formulated this point concisely: "the hierarchical structure of the covariance of ability test scores exists as a finding that is not necessarily isomorphic with anything in people's heads; the three-level hierarchy is a taxonomy of tests, not of humans' mental structures." Hence, the theory of *g* relates one set of orderings of people (individual differences in performance on a wide range of cognitive tests) to another ordering of people (individual differences in *g*), but it does not contain hypotheses on the intraindividual dynamics of problem solving. As Jensen (1998, pp. 94–95) stated,

> *g* only reflects some part of the individual differences in mental abilities . . . that undoubtedly depend on the operation of neural processes in the brain. By inference, *g* also reflects individual differences in the speed, or efficiency, or capacity of these operations. But *g* is not these operations themselves.

Clearly, these theorists on *g* do not take *g* to refer to a unitary problem-solving mechanism in the human brain, but to a single latent dimension that underlies individual differences in cognitive performance.

Kanazawa departed radically from this viewpoint. He did not interpret *g* as a latent dimension on which people differ from each other, but as a causally efficacious entity within the individual person. However, such an interpretation is not, in general, warranted (Borsboom, Mellenbergh, & Van Heerden, 2003). To see this, consider the following example: Individual differences in birth weight may be the common cause of a great number of individual differences in many variables, like health, athletic ability, and chances of survival. Now suppose that there was no direct way of measuring birth weight, just like there is no direct way of measuring *g*. Then the fact that birth weight is the common cause of observable features could be used to infer individual differences in birth weight by conceptualizing it as a latent variable that causally influences individual differences in such features and by using the standard techniques of latent variable modeling. This is not vaguely analogous but exactly parallel to what happens in the common factor model used in research on the *g* factor, where individual differences on observable test scores are used to infer differences in *g*. Now suppose that, in the case of birth weight, such an endeavor were successful. This clearly does not require or imply that birth weight is a module at work in the human being. In fact, such an inference would be entirely wrong; although the particular value that the variable birth weight takes on for any given person is undoubtedly the result of the interplay between many different modules and mechanisms, birth weight is not thereby itself a module or mechanism. This shows that one must be very careful with the interpretation of interindividual-differences variables like *g*; for if a single latent variable underlies a set of observed variables, this does not imply the working of a single intraindividual mechanism or process.

Thus, when Kanazawa interpreted the *g* factor as a module in the human mind, he was not building on a substantial body of evidence, as he suggested; rather, he departed from the body of evidence on which the *g* factor is based by presuming that the evidence for a single factor, which underlies differences between people in test scores, is evidence for a unitary module, which is at work within an individual person's head. However, evidence for a given structure of interindividual differences is not evidence for an isomorphic structure of intraindividual processes (Molenaar, 2004), and this applies to *g* as it does elsewhere. Thus, Kanazawa did not provide an explanation of the *g* factor, of which he thinks "nobody denies the existence" (2004, p. 512), but instead explained an intraindividual problem-solving mechanism that is neither implied by the evidence for *g* nor well established on independent grounds. Kanazawa has not given an explanation of an empirically established phenomenon, as he has suggested; he has provided an explanation of a hypothetical mechanism that has neither been discussed nor supported in the literature on *g*.

Of course, in itself there is no problem with introducing new hypothetical mechanisms and relating them to existing theory, for this is the gist of scientific progress. As such, one may suppose that although Kanazawa's ideas are perhaps somewhat unorthodox, they may nevertheless be correct. However, we do not think that this is the case. The reason for this is that the adaptationist line of explanation does not apply to individual-differences variables like *g* and in fact cannot apply to such variables. It is instructive, in this respect, to contrast *g* with theoretical concepts that do in principle

admit an adaptationist approach in terms of modules. Consider, for instance, the Language Acquisition Device (LAD; Pinker, 1994). The LAD was posited to account for the fact that all normal humans in normal circumstances effortlessly acquire language during their development between the ages of 0 and, say, 3. This ability is universal, is observed in all societies, and has been present since language evolved in the EEA. Thus, the LAD is posited to explain a striking phenomenon, which we can observe in any single normal infant growing up in normal circumstances. In this respect, the LAD and *g* differ importantly. General intelligence was inferred to account for a striking phenomenon, which can be observed in the distribution of IQ test scores in present societies—namely, the positive manifold. It does not explain, nor is it intended to explain, demonstrable species-typical behavior, like language acquisition or river crossing.

Jensen (2002, pp. 40–41) articulated the distinction between *g* and intraindividual problem-solving processes forcefully:

> It is important to keep in mind the distinction between intelligence and *g*. . . . The psychology of intelligence could, at least in theory, be based on the study of one person, just as Ebbinghaus discovered some of the laws of learning and memory in experiments with $N = 1$. . . . Intelligence is an open-ended category for all those mental processes we view as cognitive, such as stimulus apprehension, perception, attention, discrimination, generalization, learning and learning-set acquisition, short-term and long-term memory, inference, thinking, relational eduction, inductive and deductive reasoning, insight, problem solving, and language. The *g* factor is something else. It could never have been discovered with $N = 1$, because it reflects individual differences in performance on tests or tasks that involve any one or more of the processes just referred to as intelligence.

Clearly, the mental processes that Jensen (2002) mentioned are the ones necessary for crossing rivers and extinguishing fires—not the *g* factor. The *g* factor is about something different—namely, about a latent between-subjects dimension that accounts for the structure of individual differences in IQ scores. In contrast to the modules for language acquisition, mate selection, cheater detection, memory, or visual perception, *g* does not refer to universal human behavior but to individual differences in such behavior. And the sort of evolutionary explanation that one could devise to account for universal abilities, like language acquisition, is simply of the wrong logical type to account for the individual differences that *g* concerns.

Now, the point we are making here is not that the *g* factor cannot be subjected to an adaptationist analysis just because there exist individual differences in *g*. There exist individual differences in the efficiency and quality of many physical and psychological mechanisms that may be viewed as modules; for example, every normal human being has the capacity to spontaneously and effortlessly learn language, which may be due to the presence of the LAD, but there are vast differences across individuals in the rate at which this occurs, which may be due to individual differences in the efficiency of the LAD. Similarly, every normal human being is endowed with a heart, but some hearts work better than others. This type of individual differences is not problematic for adaptationist analyses, because modules like the LAD and the heart are defined and established at the level of the individual person. Thus, although differences between people in the efficiency of these modules may be found, these individual differences are not the basis of their existence.

The case with the *g* factor, however, is entirely different. The *g* factor is not defined or established as a mechanism at the level of the individual but is defined exclusively in terms of individual differences. It is conceptualized accordingly in the analysis of empirical data—namely, as an individual-differences variable in the factor model. This distinction is crucial because it implies that, unlike such modules as the heart or LAD, *g* is not a hypothesized mechanism within persons but a variable that ranges over persons. Hence, it cannot be present inside a person in the way psychological or physical mechanisms are. To appreciate this distinction, one may consider the fact that the heart and LAD exist in every normal human being. But *g*, if it exists, is not present within every normal human being. The existence of *g* would imply not that *g* is present within every normal human being, but that every human being occupies one of its levels, which is a statement of an entirely different character. It is important to note that this is not an empirical fact, or even a statement that could be refuted or confirmed by empirical research—it is a logical point that follows directly from the distinction between mechanisms and variables. Rather than a mechanism, the *g* factor is a variable, and one simply cannot say that a variable exists within the objects that occupy its levels; to maintain otherwise is to make a category mistake. Hence, the identification of *g* with an intraindividual module is not merely a case of overenthusiastic speculation, but a fundamental flaw.

Now we can fully articulate the problem facing Kanazawa's theory. Not only did Kanazawa go far beyond the available evidence in supposing that there exists some kind of general problem-solving module inside people's head that requires an evolutionary explanation; the situation is more serious than that. Whatever it is that Kanazawa's theory explains, the phenomenon in question must be an intraindividual problem-solving mechanism, rather than a source of individual differences. Apart from the fact that there is no evidence for the existence of such a module, it cannot be identical to the *g* factor as a matter of logic, for a between-subjects latent variable cannot be identical to a within-subject mechanism. Thus, even if Kanazawa's theory were correct, it would not be about *g*.

Where Does the Positive Manifold Come From?

The adaptationist explanatory scheme that is suited to explaining universal abilities or capacities, like the LAD (Pinker, 1994), is neither well suited, nor in fact intended, to provide an answer to the question of why individual differences are structured in a certain way. However, this does not rule out the possibility of an evolutionary psychological explanation for the existence of the positive manifold or *g*. It does rule out the possibility that such an explanation be of the same type as explanations that are based on universal adaptations. How, then, does an evolutionary explanation of individual differences work?

From an evolutionary perspective, one can distinguish between two categories of individual-differences variables, each of which is associated with a different kind of evolutionary explanation (Tooby & Cosmides, 1990; Wilson, 1994). The first category does not reflect the result of natural selection, but rather concerns essentially random fluctuations around a monomorphic, species-typical design. Such variation may, for instance, be due to the recombination of DNA that occurs because humans procreate sexually rather than via cloning (e.g., Tooby & Cosmides, 1990).

For example, normal variation in bodily height could be viewed in this manner. The genetic differences that underlie phenotypic differences in height may, of course, be the raw material on which evolution acts, and one may even suppose that the bounds within which human heights fall are a product of evolutionary forces; but the normal variation in height may have no clear adaptive function. Rather this may be purely random variation around the monomorphic design of the human body. In the context of *g*, a similar account could apply if *g* turned out to be a by-product of basic physiological or anatomical differences in human brains (e.g., nerve conductivity: Jensen, 1998; neural plasticity: Garlick, 2002; brain volume: Rushton & Ankney, 1996) that produced differences in performance on various intelligence tests but had no adaptive function.

The second category of individual differences does reflect the result of natural selection, because the very fact that there is variation within a species promotes the inclusive fitness of members of that species. Wilson (1994) gave several examples of species in which interindividual variation seems to function in this manner. For instance, within the population of arctic char, biologists have found different ecological forms, which differ, for instance, in what they eat (e.g., plankton or fish) but share the same gene pool (Wilson, 1994). The members of the species exhibit individual differences in behavior, and these differences have an adaptive function—namely, the different ecological forms do not eat the same food, which means that the environment can sustain greater numbers of char than when there was only one ecological form. Thus, a transition from a single ecological form to a plurality of forms increased the chances of survival and successful reproduction for the members of this species. Perhaps, a similar explanation holds for *g* and the positive manifold. An interesting theory of this type has been proposed by Miller (2000). He suggested that intelligence is one of many fitness indicators (i.e., observable variables that reflect differences in general inclusive fitness). Because each of these indicators reflects a general fitness factor (Miller called this factor "f"), they will form a positive manifold. Thus, according to this theory, the positive manifold of IQ test scores does not exist in isolation but is rather part of a much larger positive manifold made up of all variables that are indicators of general fitness. The evolutionary benefit of having such a positive manifold is that it makes mate selection relatively easy. Because each variable (intelligence, facial symmetry, bodily strength) is positively associated with the fitness factor, it does not matter much which of those variables is actually used to choose among different potential sexual partners. In contrast, if fitness indicators varied in an irregular fashion, the mate selection problem would become much more difficult. Thus, according to Miller, the benefit of the existence of *g* (or f) is that it promotes successful reproduction by facilitating optimal mate choice.

We are not suggesting that this evolutionary account of *g* is correct. At present, we feel that there is insufficient evidence for choosing among the many possible explanations for the origin of the positive manifold and *g*, evolutionary or otherwise. However, it is clear that whatever explanation may ultimately prove to be correct, it will have to explain why the differences we observe are characterized by the positive manifold. It is also clear that Kanazawa's theory does not have the potential for doing this, because it is devised to explain a species-typical adaptation rather than a set of individual differences. Thus, even if there were an evolutionary story to be told about the positive manifold or *g*, it would not be Kanazawa's.

Discussion

We have shown that Kanazawa's theory on the evolutionary origins of *g* is based on a misinterpretation of *g*. Specifically, we have argued that if Kanazawa's theory were correct, then it would be about a species-typical problem-solving module that is universally present in human beings. As *g* is not a problem-solving module but a hypothesized dimension of individual differences (in effect, a source of variance), Kanazawa's theory does not bear on this construct. We also argued that if an evolutionary theory of *g* were to be given, it would have to be structured along lines that differ radically from Kanazawa's proposed explanation. An evolutionary theory of individual differences must explain not why people are the same but why they differ as they do. Such a theory must show either that individual differences are random fluctuations around a monomorphic design or that a certain structure of individual differences in a species is likely to have conferred a greater inclusive fitness on the members of this species. Kanazawa's theory, however, does neither and is therefore inadequate.

Our analysis shows that Kanazawa's theory operates at the wrong level (namely, at the level of the individual) for explaining what it aims to explain (the *g* factor, which exists in the structure of individual differences). The question now arises whether there exists a way in which this defect can be repaired. It seems to us that this would require Kanazawa to show that there exists an intermediate level of analysis that could be used to relate his hypothesized intraindividual problem-solving mechanism to the empirically established structure of interindividual differences we see in the positive manifold. This might, for instance, be done by introducing the additional hypothesis that individual differences in the efficiency of Kanazawa's module are causally responsible for the structure of individual differences in the positive manifold. (To avoid confusion, we would like to note that this would not make *g* identical to this module, which remains a logical impossibility, but would rather explain individual differences in *g* on the basis of individual differences in the functioning of the module. As an instructive analogy, one might consider that if differences in visual acuity were to be explained in terms of differences in the functioning of the eye, this would not make visual acuity identical to the eye.) We do not think that ad hoc modifications of the theory in this direction will save Kanazawa's theory, given that the module is obviously not designed for the task of explaining individual differences. To relate Kanazawa's module to the positive manifold requires a theoretical argumentation that specifies the implications of intraindividual mechanisms, like Kanazawa's module, for the structure of interindividual relations, like the positive manifold. The general difficulty of this problem would lead us to expect that such argumentation is not forthcoming. But of course the supporters of Kanazawa's theory are invited to make the effort.

Alternatively, supporters of Kanazawa's theory may choose to limit the applicability of the theory to whatever processes, modules, and mechanisms exist at the level of the individual person, without extending the theory to cover individual differences. This would require evidence for the existence of a module like Kanazawa's *g* at the level of the individual. Such evidence is currently lacking; we do hope that we have made sufficiently clear that the

results from correlational research on interindividual differences, as cited and reported in Kanazawa's article, do not by themselves support the notion of an intraindividual problem-solving mechanism of the kind Kanazawa describes. Hence, if the theory is not supposed to bear on individual differences, as Kanazawa (2004, p. 521) himself seemed to suggest, then reference to evidence for the *g* factor, which is based entirely on results of individual differences, is not relevant to Kanazawa's theory. We note that if this is Kanazawa's point of view, then the title of his article as well as the many references to results from individual-differences research are confusing and require clarification. At any rate, on this viewpoint, Kanazawa has not explained the existence of *g* as the term is normally understood, as we have argued at length in this commentary.

In closing, we would like to note that the positive manifold is one of the most well-established phenomena in differential psychology. At the same time, we do not have a clear idea of why it exists. It would be a significant achievement if an evolutionary basis for the positive manifold, or *g*, were discovered. The development of testable theories on this topic therefore represents an enterprise of considerable importance. It is crucial, however, that scientists who pursue this line of research have a clear conceptualization of what *g* is and is not about. As with any scientific theory, an evolutionary explanation of *g* must start with a clear idea of what it is that requires explanation. We hope that we have made sufficiently clear that Kanazawa's theory proceeds from an erroneous conceptualization of *g*, so that future research may avoid the pitfall of the intraindividual reification of between-subjects dimensions that characterizes Kanazawa's theory.

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