

## Is domain-general thinking a domain-specific adaptation?

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### **Abstract**

According to Kanazawa (2004), general intelligence, which he considers as a synonym of abstract thinking, evolved specifically to allow our ancestors to deal with evolutionary novel problems while conferring no advantage in solving evolutionary familiar ones. We present a study whereby the results contradict Kanazawa's hypothesis by demonstrating that performance on an evolutionary novel problem (an abstract reasoning task) predicts performance on an evolutionary familiar problem (a social reasoning task).

### **Keywords:**

Reasoning, Abstract Thinking, Intelligence, Evolutionary Psychology, Domain-specificity.

## **1 Is domain-general thinking a domain-specific adaptation?**

Most evolutionary explanations of higher cognitive processes share the assumption that not only low-level perceptual systems but also the highest thinking functions depend on domain-specific modules (e.g., Cosmides and Tooby 2002). These are mechanisms which operate independently, and were designed by natural selection to solve specific problems faced by our hominoid ancestors. For instance, it has been claimed that reasoning processes depend on evolved modules which are exclusively designed to pick out cheaters in social exchange (Cosmides 1989), or to predict the frequency of uncertain events (Cosmides and Tooby 1996). Recently, Kanazawa (2004) suggested that even general intelligence (or *g*), which he considers as a synonym of abstract thinking, is a domain-specific adaptation that evolved specifically to allow our ancestors to deal with evolutionary novel problems. According to Kanazawa, in the highly stable environment of the Pleistocene epoch (from 1,640,000 to about 10,000 years ago), our ancestors had to deal with recurring problems (e.g., mating, finding food), and they could solve them by means of the specialized mechanisms shaping their mind. In other words, “our ancestors did not have to *think* [author’s emphasis]” (Kanazawa 2004, p. 514). However, despite its extreme stability, even the ancestral environment sometimes presented novel, nonrecurring problems (e.g., escaping from a fire, crossing a flood barrier). These problems could not be solved by means of the available mental mechanisms, but required a new ability: abstract thinking. If these problems occurred frequently enough, then genetic mutations that provided their carriers to think abstractly would be selected, and could become a domain-specific adaptation in order to deal with novelty. Kanazawa reported data that appeared to support his view: intelligent individuals solve evolutionary novel problems (e.g., abstract reasoning problems) better than less intelligent individuals. However, intelligent individuals have no advantage in solving evolutionary familiar problems (e.g., social reasoning problems).

Kanazawa's hypothesis is original, but it presents some problematic aspects concerning both evolution and modularity mechanisms. Referring to the former, Kanazawa's hypothesis rests on the assumption that genes can produce preformed phenotypes without any input or influence from the environment. Such a *pre-specification* assumption is challenged by many current accounts of evolution, which assume that the phenotypic traits, far from being genetically predetermined, emerge from a complex dynamic process during individual ontogeny (e.g., Lickliter and Honeycutt 2003). With this perspective, Kanazawa's hypothesis cannot explain how genetic mutations have equipped their carriers with abstract thinking in an environment in which, as Kanazawa himself recognizes, the stimulation that should have triggered its development was very rare, if not entirely absent. On the other hand, Kanazawa seems to assume that environmental forces can modify the architecture of the human mind in a very reduced temporal scale. In particular, according to Kanazawa, Caribbean Africans have higher thinking abilities than sub-Saharan Africans because the ancestors of the former moved from an evolutionary familiar to an evolutionary novel environment. However, the idea that a new environment could shape a more developed version of an evolved psychological mechanism in the space of 500 years at most contrasts with his pre-specification assumption as well as with the commonly assumed lengthy time frames of biological evolution. (We do not consider here the assumption that in the course of human evolution and history "much of the social (interpersonal) environment has remained the same", Kanazawa (2004, p. 512). North (2005) presents convincing arguments against this assumption).

As for modularity, it is worth recalling that standard modular accounts of the mind attribute properties like *obligatory firing*, *fast speed* or *shallow outputs* to lower level processes, but not to higher level ones (Fodor 1983). As a matter of fact, such properties do not seem to be easily extendible to abstract thinking. For example, consider the cognitive

processes involved in the construction of a new scientific theory of intelligence. They involve abstract thinking but they do not proceed in a mandatory manner, so much so that, given the same evidence, only few researchers develop the same theory. They are unlikely to operate at a fast rate. Furthermore, in most cases, they result in a very sophisticated output. Unfortunately, Kanazawa (2004) does not provide an alternative definition of modularity, nor does he explain in what sense such a specific modular organization would be advantageous.

These theoretical problems are relevant. Nevertheless, our aim is to establish whether Kanazawa's hypothesis is empirically adequate. Borsboom and Dolan (2006) have convincingly argued that his hypothesis does not actually concern general intelligence, because in standard psychometric literature *g* is a source of individual differences and not a mechanism that operates at an individual level. However, given that Kanazawa (2004) has explicitly equated *g* with "the ability to think abstractly" (p. 515), the question still remains as to whether the hypothesis of abstract thinking as a domain-specific adaptation is empirically founded. In what follows, we report the results of a study in which we have directly tested Kanazawa's predictions.

According to Kanazawa, his theory suggests two complementary empirical hypotheses: "1. Intelligent (high-*g*) individuals are better able to solve problems than less intelligent (low-*g*) individuals, *only if* [author's emphasis] the problems are evolutionarily novel. 2. Intelligent (high-*g*) individuals are no more able to solve problems than less intelligent (low-*g*) individuals, *if* the problems [...] are [...] evolutionarily familiar" (p. 515). Actually, the two statements above are logically equivalent. A "*P only if Q*" statement has the same truth conditions as its contrapositive "*if not-Q then not-P*": both are false only when the contingency "*P & not-Q*" is the case (e.g., a situation in which intelligent individuals are better able to solve an evolutionary familiar problem). Hence, they convey the same

hypothesis: if the problem is evolutionary familiar, then all individuals should perform equally well, regardless of their levels of intelligence.

The trouble with this hypothesis is that it fails to consider the possibility that individuals' reasoning performance depends on the computational and representational difficulty of the problem to solve rather than on its alleged degree of evolutionary novelty. In particular, Kanazawa predicts that intelligent individuals should outperform less intelligent individuals in abstract reasoning tasks, but not in tasks that require them to reason about evolutionary familiar matters like social contracts. To explicate his predictions, Kanazawa refers to the notorious selection task (Wason 1966). In the standard version of this task, individuals are presented with four cards (e.g., A, B, 2, 3), each with a letter on one side and a number on the other. They are asked to indicate the card/cards they need to turn over in order to know whether a conditional statement (e.g., "*If there is an A on one side of a card, then there is a 2 on the other side*") is true or false. This version requires searching for counterexamples, an evolutionary novel problem in Kanazawa's terms. Indeed, very few individuals (the most intelligent ones in Kanazawa's terms) solve it. Individuals solve the selection task much better when it concerns social contracts (i.e., conditional assertions having the form "*If one takes benefit P, then one must meet requirement Q*"). Following Cosmides (1989), Kanazawa (2004) argues that it is easier to reason in terms of social contracts because these evolutionary familiar situations evoke an innate "look for cheaters" procedure (i.e., a mechanism used to search for individuals who have taken benefit *P* and have not met requirement *Q*). The point is that Kanazawa's generic distinction between "abstract logical problems" and "social contract problems," in which the former are considered difficult and the latter easy tasks, conflicts with the available evidence on human reasoning processes. Some abstract problems are actually very difficult to solve and might yield illusory inferences even in very intelligent individuals (e.g., Johnson-Laird et al. 2000). Some others are not. For instance, virtually all

individuals are able to draw valid inferences from a *modus ponens* argument (i.e., the correct conclusion “*Q*” from the premises “*If P, then Q*” and “*P*”), even when it concerns abstract material. Similarly, most individuals solve the abstract version of the selection task, when it makes the potential counterexamples relevant (Sperber et al. 1995). An analogous variability has been reported for problems presenting evolutionary familiar contents. For example, individuals typically solve selection tasks concerning social rules, including rules lacking the canonical structure of a social contract (Giroto et al. 1989; Sperber and Giroto 2003). However, they fail selection tasks concerning standard social contracts, when possible rule-abiding cases are more relevant than possible cheating cases (Giroto et al. 2001; Sperber and Giroto 2003). In sum, contrary to the evolutionary account, the degree of abstractness of the content (or in Kanazawa’s (2004) terms, its degree of evolutionary novelty) does not appear to be the main determinant of performance in reasoning problems like, in particular, the selection task (for similar conclusions, see e.g., Almor and Sloman 1996; Carlisle and Shafir 2005; Hilton et al. 2005; Johnson-Laird 2006).

Since the social contract versions of the selection task vary in difficulty, we predict that individuals who perform better in the standard selection task should also perform better in a difficult social contract version. In other words, we predict that individuals with higher abstract reasoning abilities (see Kanazawa 2004, p. 516) should outperform individuals with lower abstract reasoning abilities in an evolutionary familiar problem. We have tested this prediction, which is at odds with the one that derives from Kanazawa’s hypothesis, in a study where we compared the performance in two versions of the selection task. One was the standard (or, in Kanazawa’s terms, abstract) selection task concerning letters and numbers. The other one was a social contract selection task that has been proved to elicit a moderate rate of correct performance, possibly because it makes the potential rule-abiding cases more relevant than the potential cheating cases (see Sperber and Giroto 2003). Following

Kanazawa's (2004, p. 516) hypothesis, the performance in the standard version should not predict the performance in the social contract version:

...Thus my theory would predict that high-g individuals would perform better than low-g individuals at solving the Wason selection tasks when stated as abstract logical problems. In contrast, since cheater detection is evolutionarily familiar and is handled by a different module than "general intelligence"..., high-g individuals should do no better than low-g individuals at solving the Wason selection tasks when stated as social contracts.

By contrast, following our prediction, individuals who solve the standard version should also perform better in the social contract version

## **2 Method**

### **2.1 Participants**

Sixty-five students (41 males and 24 females) from the Polytechnic of Milan volunteered to participate in the experiment. Their mean age was 24 years.

### **2.2 Procedure and Materials**

The participants were tested individually or in small groups. All of them tackled both versions. Half the participants were given the problem in the standard version first, for the other half the order was inverted. The text of the two versions (translated from the original Italian) read as follows:

#### *Standard version*

Luisa finds a deck of cards. She hypothesizes that such a deck respects the following rule:

*If on the blue face of a card there is a vowel, on the yellow face there is an even number.*

Below you see four cards. Each card has a blue side on which there is a letter, and a yellow side on which there is a number. For each card only one side is visible.

[Participants saw four cards. In the first card, the visible blue side read: "A." In the second card, the visible blue side read: "B." In the third card, the visible yellow side read: "6." In the fourth card, the visible yellow side read: "7."]

Your task is to establish whether, as far as these four cards are concerned, the above rule has been respected. With this aim, indicate only the card or the cards you definitely need to turn over.

### *Social contract version*

A group of Italian tourists visit the island of the Boro-Boro people. Some tourists and natives agree to perform the following exchange:

*If a native gives a tourist a bracelet, the tourist will send him/her a picture from Italy.*

Below you see four cards, each of which represents a different encounter between a given tourist and a given native. Each card has a blue side which indicates what the native has done, and a yellow side which indicates what the tourist has done. For each card only one side is visible. [Participants saw four cards. In the first card, the visible blue side read: "Kiku has given Paolo a bracelet." In the second card, the visible blue side read: "Kapa has given Rino nothing." In the third card, the visible yellow side read: "Enzo has send Kanesa a picture." In the fourth card, the visible yellow side read: "Nico has not sent Kori a picture."]

Your task is to establish whether, as far as these four encounters are concerned, the above rule has been respected. With this aim, indicate only the card or the cards you definitely need to turn over.

### 3 Results and Discussion

Table 1 reports the percentage of correct and incorrect answers in the two versions (social and standard) of selection task.

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Table 1 about here

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The answers in the two versions are significantly related, McNemar test  $\chi^2(1, N= 65)= 13.07, p < .001$ . In particular, all (11 out of 11) the participants who solved the standard version solved the social contract version as well. By contrast, only 28% (15 out of 54) of the participants who failed the standard version solved the social contract one. The Fisher's exact test showed an odds ratio greater than 1 (conditional maximum likelihood estimate: 3.541,  $p < .05$ ), thus corroborating our hypothesis: performance in the standard selection task could be used to predict performance in a difficult version of the social contract task.

Kanazawa assumed that abstract thinking is necessary to solve the standard version of the selection task and that the social contract versions of this task are evolutionary familiar problems. Accordingly, from our results one has to conclude that abstract thinking abilities can confer advantage in solving evolutionary familiar problems.

### 4 Conclusions

In this paper, we have examined the empirical base of Kanazawa's (2004) hypothesis that abstract thinking is a domain-specific adaptation. The results of our study contradict this hypothesis by showing that individuals who are better able to solve the standard version of the selection task are also better able to solve a social contract selection task. It is questionable whether these individuals have to be considered more intelligent than individuals who fail the standard selection task, and whether a social contract selection task is actually an evolutionary familiar problem (Sperber and Girotto 2002, 2003). Our study was

not aimed to answer these questions, neither to establish whether the mechanisms involved in solving the two tasks are the same or whether they are different but influenced to the same extent by individual differences in intelligence. The aim of our study was simpler, that is, to test Kanazawa's (2004, p. 516) hypothesis that the ability to solve a standard selection task does not predict the ability to solve a social contract task. Contrary to Kanazawa's prediction, our results demonstrate that participants who, following Kanazawa's own criteria, should be considered more intelligent individuals outperform less intelligent ones in a reasoning task that in Kanazawa's terms is an evolutionary familiar problem.

Kanazawa (2004, p. 516) used Stanovich and West's (1998) results to support his hypothesis. Indeed, Stanovich and West (Experiment 2) reported no difference in SAT scores between solvers and non-solvers of the Drinking-age Problem (i.e., a selection task whose conditional rule has the form of a social contract, see Cosmides 1989). The point is that in two other studies, Stanovich and West (1998/Experiment 1 and 3) did find a significant relation between responses on a more difficult version of this task and SAT scores. The difference in SAT scores disappeared only when participants who had also solved a standard problem were eliminated (see Stanovich and West 1998, p. 218). In other words, Stanovich and West failed to observe differences in SAT scores only by eliminating the individuals that they considered the more intelligent ones: "Individuals who solve [the standard selection task] are disproportionately people of higher cognitive ability" (p. 217, square brackets added). Moreover, Stanovich and West (1998/Experiment 2) found that participants who solved a social contract selection task introduced by Cosmides (1989), had higher SAT scores than participants who failed it. Stanovich and West (1998, p. 219) attributed this finding to the ambiguous nature of the social contract used in their task: it may have evoked an indicative interpretation in some subjects and a social contract interpretation in others. We believe that these findings complement our results and corroborate our hypothesis. Given a

difficult social contract problem, individuals with higher abstract reasoning abilities are more likely to find a better solution than individuals with lower abstract reasoning abilities (for related conclusions concerning strategic reasoning problems, see Bhatt and Camerer 2005). The finding that reasoning about social contracts is not always easy contradicts Kanazawa's (2004) hypothesis that all problems concerning social contracts are equivalent and easily solved by means of an evolved mechanism. Sceptics might argue that a difficult social contract problem is not a proper social contract problem. The trouble with this objection is that the problem we have used (adapted from Sperber and Girotto 2003) has the canonical requirement-benefit structure which, according to the advocates of the look-for-cheaters hypothesis (see e.g. Fiddick, et al. 2000, p. 41, n. 24), should automatically yield the selection of the cards representing potential cheaters (i.e., individuals who have taken benefit  $P$  and have not met requirement  $Q$ ). Moreover, the problem we have used is a genuine Wason selection problem because it asks for a question about the truth or falsity (in the standard version) or the respect or violation (in the social contract version) of a conditional rule. Unfortunately, some social contract problems used in previous studies (e.g., Fiddick et al. 2000) asked participants to see whether any cheating had taken place. In spite of superficial similarities, this sort of problem is not a genuine Wason selection problem, but a trivial categorization task, in which participants have simply to select the cards that could represent an instance of a given category. (Indeed, most participants solve this sort of task, regardless of whether the category is an evolutionary significant one or not; see Sperber and Girotto 2002). By contrast, in the problem we have used, participants have to answer the proper Wason question as to whether or not a social contract rule has been respected.

To corroborate his hypothesis, Kanazawa (2004) also reported correlational data that apparently show the independence of abstract thinking from other evolved cognitive mechanisms, as those underlying the solution of evolutionary familiar tasks, like *mating* and

*parenting*. Several elements, however, suggest that the way in which such data have been obtained and used does not support Kanazawa's conclusions. First, Kanazawa's operationalization of the relevant variables is disputable. Some of his measures of achievement in evolutionary familiar tasks are just questionable proxies for domain-specific adaptations. For instance, Kanazawa concludes that "intelligent people have lower inclusive fitness than less intelligent people" (p. 517) on the basis of a negative correlation between the *number of children* the respondents have had and abstract thinking. But, as Kanazawa himself admits, the number of children is not the sole determinant of inclusive fitness given that "investing in kin is a very important means of increasing inclusive fitness" (p. 518). Now, suppose one measures inclusive fitness in terms of *parental care*. Following Kanazawa's claim that "intelligent individuals make better parents" (p. 516), the conclusion would be completely reversed: a lower inclusive fitness for less intelligent individuals. Kanazawa's operationalization of abstract thinking itself is problematic too. His thesis assumes the independence of abstract thinking from language. Yet, he has measured the former only by means of a verbal task. Second, many correlations reported by Kanazawa are difficult to interpret because of the potential effect of third variables not included in the hypotheses. For instance, to support the independence of *abstract thinking* and *parenting*, he refers to the evidence that "very bright women marry later" and, as a consequence, "are more likely to have children who are behind in motor and social development" (p. 516). The trouble with this conclusion is that bright women might marry later because of other factors, for instance a greater tendency to pursue *more demanding careers*. Hence, if one controls for these sort of variables, the negative correlation between *abstract thinking* and *age of marriage/parenting* is likely to disappear. Third, many correlations reported by Kanazawa concern the relation between objective performance in a task and potentially inaccurate self-reported scores (e.g., self-reported measures of mating behaviour). Fourth, these correlations

are often smaller than 0.1, and reach significance only because they have been computed with data sets composed of answers from thousands of respondents in a social survey. The latter problem suggests that evolutionary hypotheses about human behaviour should not be tested only by computing correlations “from social survey data, where the possibility of rejecting a true null hypothesis with large data sets is all too common an occurrence” (Volscho 2005, p. 735).

In conclusion, our study fails to find empirical support to the hypothesis of domain-general thinking as a domain-specific adaptation. Along with the indicated weakness of Kanazawa’s (2004) data and analysis, the reported results confirm the limits of the current evolutionary accounts of human reasoning.

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**Table 1** Percentage of correct and incorrect answers, by problem version

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	Standard version	
Social contract version	Correct	Incorrect
Correct	17	23
Incorrect	0	60

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*Note.* N = 65