Sex Differences In Mind: Keeping Science Distinct From Social Policy

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Acknowledgements: Parts of this chapter were presented in the Darwin Lecture Series, Cambridge University, 2005. The author was supported by the MRC and the Nancy Lurie Marks Family Foundation during the preparation of this work.

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There are interesting differences between the *average* male and female mind. In using the word 'average' I am from the outset recognizing that such differences may have little to say about individuals. In addition, the differences are subtle, and are to do with the relative proportions of different drives in the typical male and female mind. The field of sex differences in psychology in the 1960s and 70s, was so conflict-ridden as to make an open-minded debate about any possible role of biology contributing to psychological

sex differences impossible. Those who explored the role of biology – even while acknowledging the importance of culture – found themselves accused of defending an essentialism that perpetuated inequalities between the sexes, and of oppression. Not a climate in which scientists can ask questions about mechanisms in nature. Today, the pendulum has settled sensibly in the middle of the nature-nurture debate, and scientists who care deeply about ending inequality and oppression can at the same time also talk freely about biological differences between the average male and female brain and mind.

My own view is that the field of sex differences in mind needs to proceed in a fashion that is sensitive to this history of conflict by cautiously looking at the evidence and being careful not to overstate what can be concluded. Once again, the evidence says nothing about individuals. As we will see, the data actually require us to look at each individual on their own merits, as individuals may or may not be typical for their sex. In this essay I will first look at the evidence from scientific studies of sex differences in the mind. At the end of the essay, in keeping with the theme of this edited collection, I then consider the separate social policy issue of whether as a society, if we wish to aim to achieve equal representation of women and men in science, we can achieve that.

Systemizing and Empathizing

"Empathizing" is the drive to identify another person's emotions and thoughts and to respond to these with an appropriate emotion. Empathizing allows you to *predict* a person's behavior and to care about how others feel. In this essay, I review the evidence that, in general, females spontaneously empathize to a greater degree than do males. "Systemizing" is the drive to analyze the variables in a system in order to derive the underlying rules that govern its behavior. Systemizing also refers to the drive to construct

systems. Systemizing allows one to *predict* the behavior of a system and to control it. I review the evidence that, on average, males spontaneously systemize to a greater degree than do females (Baron-Cohen, Wheelwright, Lawson, Griffin, & Hill, 2002).

Empathizing is close enough to the standard English definition to need little introduction, and I will come back to it shortly. But systemizing is a new concept and needs a little more definition. By a "system" I mean something that takes inputs and deliver outputs. To systemize, one uses "if-then" (correlation) rules. The brain zooms in on a detail or parameter of the system and observes how this varies. That is, it treats a feature of a particular object or event as a variable. Alternately, a person actively, or systematically, manipulates a given variable. One notes the effect(s) of operating on one single input in terms of its effects elsewhere in the system (the output). The key data structure used in systemizing is [input-operation-output]. If I do *x*, *a* changes to *b*. If *z* occurs, *p* changes to *q*. Systemizing therefore requires an exact eye for detail.

There are at least 6 kinds of systems that the human brain can analyze or construct, as shown in Table 1. Systemizing is an inductive process. One watches what happens each time, gathering data about an event from repeated sampling, often quantifying differences in some variables within the event and observing their correlation with variation in outcome. After confirming a reliable pattern of association—that is, generating predictable results—one forms a rule about how a particular aspect of the system works. When an exception occurs, the rule is refined or revised. Otherwise, the rule is retained. Systemizing works for phenomena that are ultimately lawful, finite, and deterministic. The explanation is exact, and its truth-value is testable. ("The light went on because the switch was in the down position.") Systemizing is of almost no use for

predicting moment-to-moment changes in a person's behavior. To predict human behavior, empathizing is required. Systemizing and empathizing are wholly different kinds of processes.

Empathizing involves the attribution of mental states to others and involves an appropriate affective response to the other's affective state. It includes not only what is sometimes called "theory of mind," or mentalizing. (Morton, Leslie, & Frith, 1995) but also encompasses the common English words "empathy" and "sympathy." Although systemizing and empathizing are in one way similar because they are processes that allow us to make sense of events and make reliable predictions, they are in another way almost the opposite of each other. Empathizing involves an imaginative leap in the dark in the absence of complete data. ("Maybe she didn't phone me because she was feeling hurt by my comment.") The causal explanation is at best a "maybe," and its truth may never be provable. Systemizing is our most powerful way of understanding and predicting the law-governed inanimate universe. Empathizing is our most powerful way to understand and predict the social world. Ultimately, empathizing and systemizing depend on separate, independent regions in the human brain.

The Main Brain Types

In this essay I will argue that systemizing and empathizing are 2 key dimensions that define the male and female brain. We all have both systemizing and empathizing skills. One can envisage 5 broad types of brain, as Table 2 shows. This essay concerns itself primarily with those on the extreme male brain end of the spectrum. Individuals who have this psychological profile may be talented systemizers, but they are often, at the same time, "mind-blind." (Baron-Cohen, 1995) The evidence reviewed here suggests that

not all men have the male brain and not all women have the female brain. Expressed differently, some women have the male brain, and some men have the female brain. My central claim here is only that *more* males than females have a brain of type S, and *more* females than males have a brain of type E. Type S means the person has the profile of S>E (their systemizing is stronger than their empathy) and type E means the person has the opposite profile (E>S). I will review the evidence supporting these profiles. In the final section of this essay, I will highlight the role of culture and biology in these sex differences.

The Female Brain: Empathizing

What is the evidence for female superiority in empathizing? In the studies summarized here, sex differences of a small but statistically significant magnitude have been found.

- *Sharing and turn taking*. On average, girls show more concern for fairness, while boys share less. In one study, boys showed 50 times greater competition, as compared to girls, while girls showed 20 times greater turn taking, as compared to boys. (Charlesworth & Dzur, 1987).
- *Rough and tumble play or "rough housing"* (wrestling, mock fighting, etc). Boys show more of this than do girls. Although such activity is often playful, it can hurt or be intrusive. Lower empathizing levels are necessary to engage in rough and tumble play (Maccoby, 1998).
- *Responding empathically to the distress of other people.* Girls from the age of 1 year show greater concern for others through sad looks, sympathetic vocalizations, and comforting as compared to boys. Also, more women than men report frequently

sharing the emotional distress of their friends. Women also show more comforting, even to strangers, than men do (Hoffman, 1977).

- *Using a "theory of mind."* As early as 3 years of age, little girls are ahead of boys in their ability to infer what people might be thinking or intending (Happe, 1995).
- *Sensitivity to facial expressions*. Women are better at decoding nonverbal communication, picking up subtle nuances from tone of voice or facial expression, or judging a person's character (Davis, 1994).
- *Empathy*. Women score higher than men on questionnaires designed to measure empathic response (Baron-Cohen & Wheelwright, 2004).
- *Values in relationships*. More women than men value the development of altruistic, reciprocal relationships, which by definition require empathizing. In contrast, more men value power, politics, and competition (Ahlgren, 1979). Girls are more likely to endorse cooperative items on a questionnaire and to rate the establishment of intimacy as more important than the establishment of dominance. In contrast, boys are more likely than girls to endorse competitive items and to rate social status as more important than intimacy (Knight & Chao, 1989).
- *Disorders of empathy.* Disorders such as psychopathic personality disorder or conduct disorder are far more common among males (Dodge, 1980; Blair, 1995)
- *Aggression*. Even in normal quantities, this can only occur with reduced empathizing. Here again, there is a clear sex difference. Males tend to show far more "direct" aggression (pushing, hitting, punching, etc), while females tend to show more "indirect" (relational, covert) aggression (gossip, exclusion, cutting remarks, etc). Direct aggression may require an even lower level of empathy than indirect

aggression. Indirect aggression needs better mind-reading skills than does direct aggression because its impact is strategic (Crick & Grotpeter, 1995)

- *Murder*. This is the ultimate example of a lack of empathy. Daly and Wilson analyzed homicide records dating back over 700 years, from a range of different societies. They found that "male-on-male" homicide was 30 to 40 times more frequent than "female-on-female" homicide (Daly & Wilson, 1988)
- *Establishing a "dominance hierarchy."* Males are quicker to establish such hierarchies. This in part reflects their lower empathizing skills because often a hierarchy is established by one person pushing others around to become the leader (Strayer, 1980).
- *Language style.* Girls' speech is more cooperative, reciprocal, and collaborative. In concrete terms, this is also reflected in girls being able to continue a conversational exchange with a partner for a longer period. When girls disagree, they are more likely to express their different opinion sensitively, in the form of a question rather than an assertion. Boys' talk is more "single-voiced discourse"; that is, the speaker presents only his own perspective. The female speech style is more "double-voiced discourse"; girls spend more time negotiating with their partner, trying to take the other person's wishes into account (Smith, 1985).
- *Talk about emotions.* Women's conversations involve much more talk about feelings, while men's conversations tend to be more object- or activity-focused (Tannen, 1990).
- *Parenting style*. Fathers are less likely than mothers to hold their infants in a face-to-face position. Mothers are more likely to follow through the child's choice of topic in

play, while fathers are more likely to impose their own topic. Also, mothers fine-tune their speech more often to match their children's understanding (Power, 1985).

- *Face preference and eye contact*. From birth, females look longer at faces, particularly at people's eyes, whereas males are more likely to look at inanimate objects (Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000).

Females have also been shown to have better language ability than males. It seems likely that good empathizing would promote language development (Baron-Cohen, Baldwin, & Crowson, 1997), and vice versa, so these factors may not be independent.

The Male Brain: Systemizing

The relevant domains to explore for evidence of systemizing include any fields that are in principle rule-governed. Thus, chess and football are good examples of systems, but faces and conversations are not. As noted previously, systemizing involves monitoring 3 elements: input, operation, and output. The operation is what was done or what happened to the input in order to produce the output. What is the evidence for a stronger drive to systemize in males?

- *Toy preferences*. Boys are more interested than girls in toy vehicles, weapons, building blocks, and mechanical toys, all of which are open to being "systemized" (Jennings, 1977).
- *Adult occupational choices*. Some occupations are almost entirely male. These include metalworking, weapon making, manufacture of musical instruments, and the construction industries, such as boat building. The focus of these occupations is on creating systems (Geary, 1998).
- *Math, physics, and engineering.* These disciplines all require high systemizing

and are largely male-dominated. The Scholastic Aptitude Math Test (SAT-M) is the mathematics part of the test administered nationally to college applicants in the United States. Males on average score 50 points higher than females on this test. (Benbow, 1988) Considering only individuals who score above 700, the sex ratio is 13:1 (men to women) (Geary, 1996). Figure 2 shows the SAT-M graphically.

- *Constructional abilities*. On average men score higher than women in an assembly task in which people are asked to put together a 3-dimensional (3-D) mechanical apparatus. Boys are also better at constructing block buildings from 2-dimensional blueprints. Lego bricks can be combined and recombined into an infinite number of systems. Boys show more interest than girls in playing with Lego. Boys as young as 3 years of age are also faster at copying 3-D models of outsized Lego pieces. Older boys, from the age of 9 years, are better than girls at imagining what a 3-D object will look like if it is laid out flat. Boys are also better at constructing a 3-D structure from just an aerial and frontal view in a picture (Kimura, 1999).
- *The Water Level Task*. Originally devised by the Swiss child psychologist Jean Piaget, the water level task involves a bottle that is tipped at an angle. Individuals are asked to predict the water level. Women more often draw the water level aligned with the tilt of the bottle and not horizontal, as is correct (Wittig, & Allen, 1984).
- *The Rod and Frame Test*. If a person's judgment of vertical is influenced by the tilt of the frame, he or she is said to be "field dependent"; that is, their judgment is

easily swayed by extraneous input in the surrounding context. If they are not influenced by the tilt of the frame, they are said to be “field independent.” Most studies indicate that females are more field dependent; i.e, women are relatively more distracted by contextual cues, and they tend not to consider each variable within a system separately. They are more likely than men to state erroneously that a rod is upright if it is aligned with its frame (Witkin, Lewis, Hertzman, Machover, Bretnall, Meissner, & Wapner, 1954).

- *Good attention to relevant detail.* This is a general feature of systemizing and is clearly a necessary part of it. Attention to relevant detail is superior in males. One measure of this is the Embedded Figures Test. On average, males are quicker and more accurate in locating a target object from a larger, complex pattern. (Elliot, 1961) Males, on average, are also better at detecting a particular feature (static or moving) than are women (Voyer, Voyer, & Bryden, 1995).
- *The Mental Rotation Test*. This test provides another example in which males are quicker and more accurate. This test involves systemizing because it is necessary to treat each feature in a display as a variable that can be transformed (e.g., rotated) and then predict the output, or how it will appear after transformation (Collins & Kimura, 1997).
- *Reading maps*. This is another everyday test of systemizing, because features from 3-D input must be transformed to a 2-dimensional representation. In general, boys perform at a higher level than girls in map reading. Men can also learn a route by looking at a map in fewer trials than women, and they are more successful at correctly recalling greater detail about direction and distance. This

observation suggests that men treat features in the map as variables that can be transformed into 3 dimensions. When children are asked to make a map of an area that they have only visited once, boys' maps have a more accurate layout of the features in the environment. More of the girls' maps make serious errors in the location of important landmarks. Boys tend to emphasize routes or roads, whereas girls tend to emphasize specific landmarks (the corner shop, the park, etc). These strategies of using directional cues versus using landmark cues have been widely studied. The directional strategy represents an approach to understanding space as a geometric system. Similarly, the focus on roads or routes is an example of considering space in terms of another system, in this case a transportation system (Galea & Kimura, 1993).

- *Motoric systems*. When people are asked to throw or catch moving objects (target directed tasks), such as playing darts or intercepting balls flung from a launcher, males tend to perform better than females. In addition, on average men are more accurate than women in their ability to judge which of two moving objects is traveling faster (Schiff & Oldak, 1990).
- *Organizable systems*. People in the Aguaruna tribe of northern Peru were asked to classify a hundred or more examples of local specimens into related species. Men's classification systems included more sub-categories (ie, they introduced greater differentiation) and were more consistent among individuals. Interestingly, the criteria that the Aguaruna men used to decide which animals belonged together more closely resembled the taxonomic criteria used by Western (mostly male) biologists. (Atran, 1994) Classification and organization involves

systemizing because categories are predictive. With more fine-grained categories, a system will provide more accurate predictions.

- *The Systemizing Quotient*. This is a questionnaire that has been tested among adults in the general population. It includes 40 items that ask about a subject's level of interest in a range of different systems that exist in the environment, including technical, abstract, and natural systems. Males score higher than females on this measure (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003).
- *Mechanics*. The Physical Prediction Questionnaire (PPQ) is based on an established method for selecting applicants to study engineering. The task involves predicting which direction levers will move when an internal mechanism of cog wheels and pulleys is engaged. Men score significantly higher on this test, compared with women (Lawson et al, 2004).

Culture and Biology

At age 1 year, boys strongly prefer to watch a video of cars going past, an example of predictable mechanical systems, than to watch a film showing a human face. Little girls show the opposite preference. Young girls also demonstrate more eye contact than do boys at age 1 year (Lutchmaya & Baron-Cohen, 2002). Some investigators argue that, even by this age, socialization may have caused these sex differences. Although evidence exists for differential socialization contributing to sex differences, this is unlikely to be a sufficient explanation. Connellan and colleagues showed that among *1-day-old* babies, boys look longer at a mechanical mobile, which is a system with predictable laws of motion, than at a person's face, an object that is next to impossible to

systemize. One-day-old girls show the opposite profile (Connellan et al., 2000). These sex differences are therefore present very early in life. This raises the possibility that, while culture and socialization may partly determine the development of a male brain with a stronger interest in systems or a female brain with a stronger interest in empathy, biology may also partly determine this. There is ample evidence to support both cultural determinism and biological determinism (Eagly, 1987; Gouchie, & Kimura, 1991). For example, the amount of time a 1-year-old child maintains eye contact is inversely related to the prenatal level of testosterone (Lutchmaya, Baron-Cohen, & Raggatt, 2002). The evidence for the biological basis of sex differences in the mind is reviewed elsewhere (Baron-Cohen, 2003).

Conclusions and Implications for Women in Science

The above evidence suggests that the male brain is characterized by type S (where S>E), the female brain by type E (where E>S). What are the implications of such research for our view of women in science? This research suggests we should not expect that the sex ratio in occupations such as maths or physics to ever be 50-50 if we leave the work place to simply reflect the numbers of applicants of each sex who are drawn to such fields. The assumption here is that just as if you leave toys out on the carpet and film if boys and girls *spontaneously* choose to play with the same or different toys, you find that more boys play with the toys that involve systemizing (constructional or mechanical toys, for example) and more girls play with the toys that involve empathizing (caring for dolls, for example), so it might be that we will always see more males *spontaneously* choosing to apply to work in fields that involve systemizing (science, engineering, auto-mechanics, etc) and more females spontaneously choosing to work in fields that involve empathy

(telephone help lines for those with mental health crises, the 'Samaritans', for example). Of course, the question of how one determines if a person's choice is 'spontaneous' or determined by cultural or biological factors is extremely hard to pin down. The study of newborn babies which found that more newborn boys *spontaneously* look for longer at a mechanical mobile, and more newborn girls spontaneously look for longer at a human face, suggests biology plays one part in leading to this 'bias' in attention to things rather than emotions (in boys) and vice versa (in girls). But this is not to minimize the major role that culture also plays in amplifying such partly innate differences as the child grows up.

A key argument, reflected in the title of this chapter, is that we should separate the scientific question ('Are there sex differences in mind?') from the social policy agenda ('How can we achieve equal representation of women in science, or in any field?'). This is because they can be considered separately. If we want a particular field to have an equal representation of men and women, which may be ethically desirable in terms of equality of opportunity, equality of status, equality of income, or ensuring balance in the work-place, then we need to put in place social policies that will bring about that outcome. In other fields, it will not be necessary to intervene with policy. Medicine is a good example of a science where female applicants now outnumber male ones, probably because it is a science that favors the Type B brain (S=E, or good systemizing together with good empathy), and Type B is actually more common among females. But math and physics may have little or no role for empathy, and so favor the Type S brain that is more common in males.

Finally, the research teaches us that there is no scientific justification for

stereotyping, since none of the studies allow one to predict an individual's aptitudes or interests on the basis of their sex. This is because – at risk of repetition – they only capture differences between groups *on average*. Individuals are just that – they may be typical or atypical for their group (their sex). The applicant for the job in your science department may be a women with a more typically 'male' brain, or may be a man with a more typically 'female' brain. Which means that to prejudge an individual on the basis of their sex is, as the word 'prejudge' suggests, mere prejudice. We need to look at applicants on the basis of who they are as individuals, not on the basis of their sex, when judging their aptitude.

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Table 1: Main Types of Analyzable Systems

- **Technical** systems (eg, a computer, a musical instrument, a hammer)
- **Natural** systems (eg, a tide, a weather front, a plant)
- **Abstract** systems (eg, mathematics, a computer program, syntax)
- **Social** systems (eg, a political election, a legal system, a business)
- **Organizable** systems (eg, a taxonomy, a collection, a library)
- **Motoric** systems (eg, a sports technique, a performance, a musical technique)

Table 2: The Main Brain Types

Profile	Shorthand Equation	Type of Brain
Individuals in whom empathizing is more developed than systemizing.	E>S	"female" (or Type E)
Individuals in whom systemizing is more developed than empathizing.	S>E	"male" (or Type S)
Individuals in whom systemizing and empathizing are both equally developed.	S=E	"balanced" (or Type B)
Individuals in whom systemizing is hyper-developed while empathizing is hypo-developed. [Individuals on the autistic spectrum have been found to fit this profile].	S>>E	extreme male brain
Individuals who have hyper-developed empathizing skills, while their systemizing is hypo-developed.	E>>S	extreme female brain (postulated)

Figure 2:

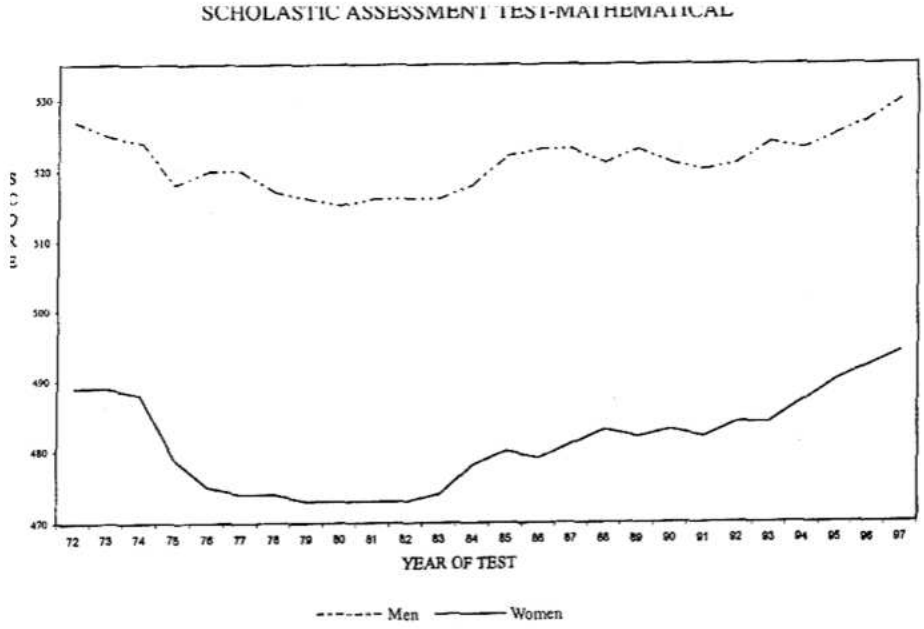
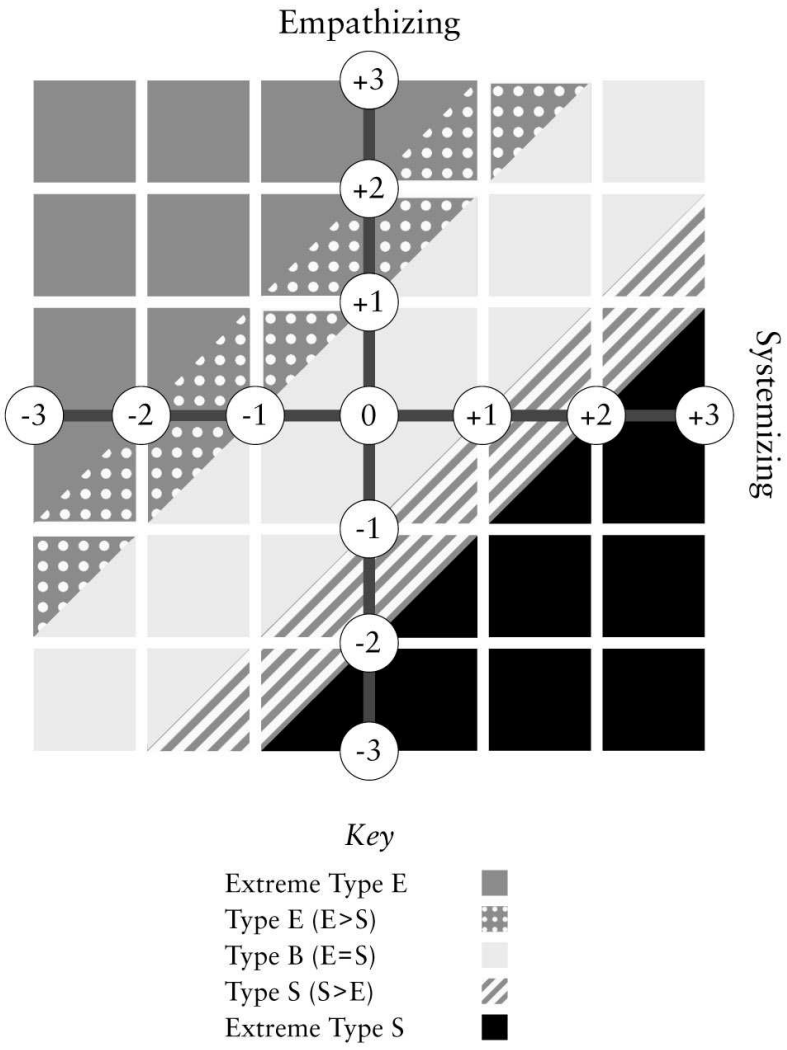


FIG. 3.9. Scholastic Assessment Test–Mathematics scores for college-bound seniors from 1972 to 1997. Data are from College Entrance Examination Board (1997).

Figure 1: A model of the different brain types



*Axes show standard deviations from the mean