

## Mach, Ernst

does his attempt to use purpose as an explanatory concept in psychology.

**Mach, Ernst** (1838–1916). Austrian physicist and philosopher of science. Born in Moravia, he studied at Vienna, and became professor of mathematics at Graz in 1864, of physics at Prague in 1867, and of physics at Vienna in 1895. His experimental work was largely on the flow of gases. His philosophical writings both laid the foundations for \*logical positivism and were a basis for Einstein's theory of relativity. (Mach's principle suggests that effects of accelerated motion, including rotation, are absolutely related to the mean mass of the universe; in practice, to the 'fixed' stars.)

Mach contributed to knowledge of \*perception, especially in his *Beiträge zur Analyse der Empfindungen* (1897; trans. C. M. Williams, *The Analysis of Sensations; and the Relation of the Physical to the Psychical*, 1959). He was among the first to use visually ambiguous figures as research tools, for separating what we now call 'bottom-up' and 'top-down' processing. (See ILLUSIONS.)

He tried to base the whole of physics on the observer's sensations. This was important philosophically, as it is an extreme form of operationalism which led to logical positivism and criteria of verification (as set out in A. J. Ayer's *Language, Truth and Logic*, 1936). The attempt has, however, turned out to be unsuccessful—unless, at least, we allow very large gaps with many unverified steps between observations (and especially sensations) and accepted facts of the world. Further, the relation between sensation and perception remains far from clear, for—as Mach himself showed—how we perceive objects affects sensations, such as surface colour and brightness. So, though important, sensations can hardly be the building blocks of perception or of physics.

Other works by Mach available in English are: *Space and Geometry: In the Light of Physiological, Psychological and Physical Inquiry*, trans. T. J. McCormack (1960); *The Principles of Physical Optics: An Historical and Philosophical Treatment*, trans. J. S. Anderson and A. F. A. Young (1926); and *The Science of Mechanics: A Critical and Historical Account of its Development*, trans. T. J. McCormack (1960).

'**mad as a hatter**'. This expression probably derives from the fact that mercury, used in the manufacture of felt, which in turn was used to make hats, produces loss of memory and other symptoms of the \*Korsakoff syndrome when absorbed by the skin. The idea is immortalized in the Mad Hatter in Lewis \*Carroll's *Alice's Adventures in Wonderland*.

**Magendie, François** (1783–1855). French physiologist, who was born at Bordeaux and died at Sannois. He studied and practised medicine in Paris, researching in many

fields and lecturing on experimental physiology, he was appointed professor of medicine at the Collège de France in 1831.

In 1809 he demonstrated that poison from the plant *Strychnos* was carried in the bloodstream and not by the lymphatics. This led to the isolation of strychnine in 1818, and he introduced it, as well as emetine, morphine, iodides, and bromides, into medical usage. He also studied nutrition scientifically, and realized the importance of proteins.

Magendie's discovery in 1822 that the dorsal root of a spinal nerve was sensory and the ventral root motor was also claimed by Sir Charles \*Bell: it is generally accepted that Magendie gave the final proof and description to work originated by Bell. His wide interests included research on the cerebellum, on olfaction, and on the circulation.

See also REFLEX ACTION.

DDH

**Maine de Biran** (Pierre-François Gonthier de Biran, 1766–1824). French philosopher. The son of a doctor from Bergerac, he held public office after the Revolution, under the Consulate and the Empire, and after the Restoration. For most of his mature life, he pursued the project of producing a single major work devoted to the Science of Man. Though he wrote extensively, this central project was never fulfilled, and he published very little during his lifetime. Most of the works subsequently published are (sometimes misleading) editorial reconstitutions and compilations. However, the historical place of his work and the main lines of development of his thought can readily be seen.

Biran marks an important transition in man's attempt to explore and understand his own mind. We must place him, on the one hand, in the introspective tradition of those like Montaigne and \*Pascal who gave prominence to the analysis and exposure of the intimacies of their own souls and, on the other hand, in the empiricist tradition stemming from \*Bacon, especially as it emerged through \*Locke and the British empiricists in the sensationalism of the 18th century propounded by authors like David Hume, \*Condillac, and Charles Bonnet. He represents the only an intersection of these traditions, but also a source of later very divergent approaches to the mind, in experimental psychology, in psychoanalysis, and in \*phenomenology.

ECTM

Moore, F. C. T. (1970). *The Psychology of Maine de Biran*. Tisserand, P. (ed.) (1920–49). *Œuvres de Maine de Biran*, 14 vols.

**male and female brain**. A new theory claims that the female brain is predominantly hard-wired for empathy, and that the male brain is predominantly hard-wired for understanding and building systems. It is known as the empathizing-systemizing (E-S) theory.

Empathizing is the drive to identify another person's emotions and thoughts, and to respond to these with an appropriate emotion. The empathizer intuitively figures out how people are feeling, and how to treat people with care and sensitivity. Systemizing is the drive to analyse and explore a system, to extract underlying rules that govern the behaviour of a system, and the drive to construct systems. The systemizer intuitively figures out how things work, or what the underlying rules are controlling a system. Systems can be as varied as a pond, a vehicle, a computer, a plant, a library catalogue, a musical instrument, a maths equation, or even an army unit. They all operate on inputs and deliver outputs, using rules.

According to this new theory, a person (whether male or female) has a particular 'brain type'. There are three common brain types. For some individuals, empathizing is stronger than systemizing. This is called a brain of type E, but we can also call it the female brain, because more females than males show this profile. For other individuals, systemizing is stronger than empathizing. This is called the brain of type S, but we can also call it the male brain, because more males than females show this profile. Yet other individuals are equally strong in their systemizing and empathizing. This is called the 'balanced brain', or a brain of type B.

Are females better at empathizing?

Are males better at systemizing?

Testosterone on the mind

The extreme male brain: autism

Other sex differences in mind

Are females better at empathizing?

The evidence for a female advantage in empathizing comes from many different directions. For example, given free choice of which toys to play with, more girls than boys will play with dolls, enacting social and emotional themes. When children are put together to play with a little movie player that has only one eyepiece, overall boys tend to get more of their fair share of looking down the eyepiece. They just shoulder the other boys out of the way. Or if you leave out those big plastic cars that children can ride on, what you see is that more little boys play the 'ramming' game. They deliberately drive the vehicle into another child. The little girls ride around more carefully, avoiding the other children more often. This suggests the girls are being more sensitive to others.

Baby girls, as young as 12 months old, respond more empathically to the distress of other people, showing greater concern through more sad looks, sympathetic vocalizations, and comforting. This echoes what you find in adulthood: more women report frequently sharing the emotional distress of their friends. Women also show more comforting than men do. When asked to judge

when someone might have said something potentially hurtful – a *faux pas* – girls score higher from at least 7 years old. Women are also more sensitive to facial expressions. They are better at decoding non-verbal communication, picking up subtle nuances from tone of voice or facial expression, or judging a person's character.

There is also a sex difference in aggression. Males tend to show far more 'direct' aggression (pushing, hitting, punching, etc.). Females tend to show more 'indirect' (or 'relational', covert) aggression. This includes things like gossip, exclusion, and bitchy remarks. It could be said that to punch someone in the face or to wound them physically requires an even lower level of empathy than a verbal snipe.

Two other ways to reveal a person's empathizing skill are to see how they (as a newcomer) join a group of strangers, and to see how they (as a host) react to a new person joining their group. This has been cleverly investigated in children by introducing a new boy or girl to a group who are already playing together. If the newcomer is female, she is more likely to stand and watch for a while, to check out what's going on, and then try to fit in with the ongoing activity. This usually leads to the newcomer being readily accepted into the group. If the newcomer is a boy, he is more likely to hijack the game by trying to change it, directing everyone's attention onto him. And even by the age of 6, girls are better at being a host. They are more attentive to the newcomer. Boys often just ignore the newcomer's attempt to join in. They are more likely to carry on with what they were already doing, perhaps preoccupied by their own interests.

How early are such sex differences in empathy evident? Certainly, by 12 months of age, girls make more eye contact than boys. But a study from Cambridge University shows that at birth, girls look longer at a face, and boys look longer at a suspended mechanical mobile. Furthermore, the Cambridge team found that how much eye contact children make is in part determined by a biological factor, prenatal testosterone. This has been demonstrated by measuring this hormone in amniotic fluid.

## 2. Are males better at systemizing?

Boys, from toddlerhood onwards, are more interested in cars, trucks, planes, guns and swords, building blocks, constructional toys, and mechanical toys—systems. They seem to love putting things together, to build toy towers or towns or vehicles. Boys also enjoy playing with toys that have clear functions—buttons to press, things that will light up, or devices that will cause another object to move.

The same sort of pattern is seen in the adult workplace. Some occupations are almost entirely male: metalworking, weapon making, crafting musical instruments, or the construction industries, such as boat-building. The focus

of these occupations is on constructing systems. Professions such as maths, physics, and engineering, which require high systemizing, are also largely male-chosen disciplines.

Some psychological tests also show the male advantage in systemizing. For example, in the mental rotation test, you are shown two shapes, and asked if one is a rotation or a mirror image of the other. Males are quicker and more accurate on this test. Reading maps has been used as another test of systemizing. Men can learn a route in fewer trials, just from looking at a map, correctly recalling more details about direction and distance. If you ask boys to make a map of an area that they have only visited once, their maps have a more accurate layout of the features in the environment, e.g. showing which landmark is south-east of another.

If you ask people to put together a three-dimensional mechanical apparatus in an assembly task, on average men score higher. Boys are also better at constructing block buildings from two-dimensional blueprints. These are constructional systems. The male preference for focusing on systems again is evident very early. The Cambridge study found that at 1 year old, little boys showed a stronger preference for watching a film of cars (mechanical systems), rather than a film of a person's face (with lots of emotional expression). Little girls showed the opposite preference. And at 1 day old, little boys look for longer at a mechanical mobile.

Culture and socialization play a role in determining whether you develop a male brain (stronger interest in systems) or a female brain (stronger interest in empathy). But these studies of infancy strongly suggest that biology also partly determines this.

### 3. Testosterone on the mind

Some of the most convincing evidence for biological causes comes from studies of the effects of hormones. There was a time when women were prescribed a synthetic female hormone (diethylstilbestrol), in an attempt to prevent repeated spontaneous miscarriages. Boys born to such women are likely to show more female-typical, empathizing behaviours, such as caring for dolls. And if a female rat is injected at birth with testosterone, she shows faster, more accurate maze learning, compared with a female rat who has not been given such an injection. So masculinizing the rat hormonally improves her spatial systemizing.

Some important lessons have been learnt from studies of clinical conditions. Male babies born with IHH (idiopathic hypogonadotrophic hypogonadism) have very small testes (and therefore very low levels of testosterone) and they are worse at spatial aspects of systemizing, relative to normal males. Other male babies born with androgen insensitivity (AI) syndrome (testosterone is an

androgen) are also worse at systemizing. Compare them to female babies born with CAH (congenital adrenal hyperplasia), who have unusually high levels of androgen and who have enhanced spatial systemizing.

But even leaving aside these clinical conditions, there is evidence for the effects of hormones on the mind in the typical child: a Cambridge study found that toddlers who had lower fetal testosterone had higher levels of eye contact. Eye contact may be related to sociability and empathizing. And a group of Canadian researchers found that the higher your prenatal testosterone the better you do on the mental rotation (systemizing) test.

### 4. The extreme male brain: autism

The E-S theory does not stereotype. Rather, it may help to explain why individuals are typical or atypical for their sex. It may help us understand the childhood neurological conditions of \*autism and Asperger syndrome, which appear to be an extreme of the male brain. Such individuals may have impairments in empathizing alongside normal or even talented systemizing.

### 5. Other sex differences in mind

Earlier studies of psychological sex differences focused on what is sometimes called 'the holy trinity' spatial ability, mathematical ability, and verbal ability. The first two of these are areas where males perform at a higher level, and the last of these typically shows a female advantage. However, spatial and mathematical abilities involve systemizing, and so may simply be further evidence for the E-S theory. Verbal ability may have nothing to do with empathy, in which case this will need to be regarded as an additional dimension along which the sexes differ psychologically. However, good empathizing and good verbal skills both facilitate communication, so that verbal and empathy skills may not be truly independent.

Baron-Cohen, S. (2003). *The Essential Difference: Men, Women and the Extreme Male Brain*

Kimura, D. (1997). *Sex and Cognition*.

**Malthus, Thomas Robert** (1766–1834) English economist and mathematician, born at Dorking, Surrey, and educated at Jesus College, Cambridge. His *Essay on the Principle of Population* (published anonymously in 1798, enlarged, 1803) inspired, or triggered, both Charles \*Darwin and Alfred Russel \*Wallace to develop the theory of evolution of species by natural selection. The key idea was struggle for survival with limited resources.

**mania.** A form of mental disorder manifested by uncontrolled excitement, overactivity, and obsessive behaviour.

**manic depressive.** A personality oscillating between overactivity and inability to summon up energy to make decisions. In extreme form, it is *manic-depressive*.