eMOTIONAL CITIES:
Mapping the cities through the senses of those who make them

Theoretical framework
Glossary of concepts and terminology used in the scoping reviews

Deliverable D2.1

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MOTIONAL CITIES
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Document Control Sheet

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Deliverable</th>
<th>D2.1 - Glossary of concepts and terminology used in the scoping reviews</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Work package</td>
<td>WP2 - Theoretical framework</td>
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<tr>
<td></td>
<td>Task</td>
<td>T2.1 – Identify the terminology to be used in the scoping reviews</td>
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<tr>
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<td>MSU, FMUL</td>
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<td>Peer reviewer</td>
<td>TT</td>
</tr>
</tbody>
</table>
Index

1. Executive Summary ........................................................................................................... 2

2. Introduction ......................................................................................................................... 4

3. Urban Environments and Health .......................................................................................... 6

   3.1 Terms for Urban Environments ...................................................................................... 6
   3.1.1 Physical Environment ................................................................................................. 6
   3.1.2 Natural Environment .................................................................................................. 7
   3.1.3 Transportation ........................................................................................................... 9
   3.1.4 Uncategorised ........................................................................................................... 10

   3.2 Terms for Health and Public Health .............................................................................. 10

4. Neuroscience: cognition and emotion - Glossary ................................................................. 30

   4.1 General Neuroscience .................................................................................................... 30
   4.1.1 Neuron and neural system ......................................................................................... 30
   4.1.2 Neuronal regions ....................................................................................................... 36
   4.2 Cognition ....................................................................................................................... 44
   4.3 Emotion ........................................................................................................................ 57
   4.4 Terms for Mental Health ............................................................................................... 63

5. Neuroscience: methodologies - Glossary ............................................................................ 72

   5.1 Functional magnetic resonance (fMRI) ......................................................................... 72
   5.2 Electroencephalography (EEG) .................................................................................... 94
   5.3 Other neuroscience-related methodologies .................................................................... 100

6. References .......................................................................................................................... 103

   6.1 Urban Environments and Health ................................................................................... 103
   6.2 Neuroscience: cognition and emotion .......................................................................... 106
   6.3 Neuroscience: methodologies ....................................................................................... 108
Chapter 1

Executive Summary
1. Executive Summary

This document is the deliverable “D2.1 - Glossary of concepts and terminology used in the scoping reviews” of the European project “eMOTIONAL Cities - Mapping the cities through the senses of those who make them” (hereinafter also referred to as “eMOTIONAL Cities”, project reference 945307).

This glossary seeks to define and explain some of the main terms or concepts, as well as methodologies, underpinning the use of neuroscience to understand the relationships between urban environments and health. It draws on published literature and glossaries experience gained over several years by the researchers, and discussions within the consortium.

The result is a comprehensive glossary of terms covering of relevant terms commonly used in urban planning research, public health research and neuroscience. It will be critical to the mutual understanding across disciplines, at the same time as it paves the way for the scoping reviews and the preliminary eMOTIONAL Cities conceptual framework.
Chapter 2

Introduction
2. Introduction

This report is one of the first deliverables in Work Package 2. This report essentially lays out a glossary of terms that are typically used in research relating to urban environments, public health, and neuroscience. The list of terms to be included in this glossary were identified through multiple processes that included brainstorming with the collaborators on this Work Package and content analysis of various formal, governmental and institutional documents that speak to this topic. With this being the first step in this process, it enabled a narrowing of concepts to be finally used in the scoping reviews that follow this initial step.

This document, therefore, presents concepts and terminologies that are categorized under the main headings of Urban Environments and Public Health in Chapter 3 and Neuroscience in Chapter 4. This document takes a further step by laying out concepts typically used specifically in the Methodologies and Technicalities that are usually involved in research involving urban environments and neuroscience in Chapter 5. This document is essential to this project as it involves two very different disciplines: Urban Planning and Neuroscience. Researchers in both disciplines use very different concepts in their research and even some common concepts are understood and used in different contexts.

Finally, this document is not meant to be exhaustive, rather encompassing the most commonly used terms and concepts. It will help readers from any discipline to get a basic understanding of concepts that will be used and referred to throughout the project and in other documents.
Chapter 3

Urban Environments and Health - Glossary
3. Urban Environments and Health

This chapter presents a glossary of terms typically used in Urban Environments and Health research within the social sciences.

3.1 Terms for Urban Environments

3.1.1 Physical Environment

**Block**: (or Census Block) Statistical areas bounded by visible features such as roads, streams, and railroad tracks, and by non-visible boundaries such as property lines, city, township, school district, county limits and short line-of-sight extensions of roads.

**Building**: A usually roofed and walled structure built for permanent use (as for a dwelling).

**Built environment**: The man-made or modified structures that provide people with living, working, and recreational spaces. (WHO, 2020) OR Buildings, roads, parks, and all other improvements constructed by people that form the physical character of a community.

**City**: An inhabited place of greater size, population, or importance than a town or village.

**Commercial**: A land use classification that permits facilities for the buying and selling of commodities and services.

**Community**: A group of people with diverse characteristics who are linked by social ties, share common perspectives, and engage in joint action in geographical locations or settings.

**Design**: Process of envisioning and planning the creation of objects, interactive systems, buildings, vehicles, etc.

**Develop**: Building and designing urban areas. Encompassed in that process is the use of open land, air, water, and the built environment, including buildings, transportation, economic and social functions.

**District**: A territorial division (as for administrative or electoral purposes).

**Infrastructure**: Public services and facilities like sewage-disposal systems, water-supply systems, other utility systems, schools, roads, bicycle and pedestrian facilities, and transit systems.
Land-use: The term used to describe the human use of land. It represents the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and recreational uses) that are practiced at a given place. Public and private lands frequently represent very different uses. For example, urban development seldom occurs on publicly owned lands (e.g., parks, wilderness areas), while privately owned lands are infrequently protected for wilderness uses.

Neighbourhood/Neighbourhood: A section lived in by neighbours and usually having distinguishing characteristics.

Local: Primarily serving the needs of a particular limited district.

Peri-urban: Areas that surround our metropolitan areas and cities.

Physical environment: Land, air, water, plants and animals, buildings and other infrastructure, and all of the natural resources that provide our basic needs and opportunities for social and economic development.

Region: (~Regional) Pertaining to activities or economies at a scale greater than that of a single jurisdiction and affecting a broad geographic area.

Residential: Land designated in the city or county general plan and zoning ordinance for buildings consisting only of dwelling units. May be improved, vacant, or unimproved land.

Rural: Any population, housing, or territory NOT in an urban area.

Street: Local streets not shown on the General Plan Circulation Plan, Map, or Diagram, whose primary intended purpose is to provide access to fronting properties.

Town: A compactly settled area usually larger than a village but smaller than a city.

Urban: Of, relating to, characteristic of, or constituting a city.

3.1.2 Natural Environment

Biodiversity corridors: Areas of vegetation that allow animals to travel from one patch of native forest to another.

Blue space: Visible outdoor natural water environments, previously often assumed under the “green spaces”.
Garden: (or Community Garden) Places where neighbours and residents can gather to cultivate plants, vegetables, and fruits and depending on local laws, keep bees and raise chickens or other livestock and poultry.

Green corridors: Linear natural infrastructure, such as trees and plants, that link up other green and open spaces to form a green urban network.

Green spaces: Open, undeveloped land with natural vegetation.

Landscape: A landscape is part of the Earth’s surface that can be viewed at one time from one place. It consists of the geographic features that mark, or are characteristic of, a particular area.

Light pollution: Artificial outdoor lighting extending over its functional role (to enhance visibility or aesthetics in the night-time environment). Light pollution comes in many forms, including sky glow, light trespass, glare, and over illumination.

Natural environment: Non-human-made surroundings and conditions in which all living and non-living things exist on Earth.

Noise: Any sound that is undesirable because it interferes with speech and hearing, is intense enough to damage hearing, or is otherwise annoying.

Park: Open space lands whose primary purpose is recreation.

Pollution: A change in the physical, chemical, or biological characteristics of the air, water, or soil that can affect the health, survival, or activities of one or more forms of life in an unwanted way.

Urban agriculture: The growing of plants and the raising of animals within and around cities” to provide fresh food, generate employment, recycle waste, and strengthen cities' resilience to climate change.

Urban farming: The practice of cultivating, processing, and distributing food in or around a village, town, or city.

Urban forest: (~Urban Forestry) Tree populations in urban settings maintained to improve the urban environment.

Urban gardening: Practice of growing plants in an urban environment.
3.1.3 Transportation

**Access:** A way of approaching or entering a property. Access includes ingress, the right to enter, and egress, the right to leave. In zoning and subdivision regulations, recorded lots are required to have direct access to a public street or highway or to a private street meeting public standard. This guarantees entry by owners and emergency vehicles.

**Commuter:** To travel back and forth regularly (as between a suburb and a city).

**Driving:** The control and operation of a motor vehicle.

**Mental maps:** A mix of objective knowledge and subjective perceptions: precise knowledge about the location of geographic features as well as impressions of places, rough estimates of size and location, and a general sense of the connections between places.

**Mobility:** The quality or state of being mobile or movable (Merriam-Webster, 2021)

**Transit:** The conveyance of persons or goods from one place to another by means of a local or regional public transportation system.

**Spatial navigation:** Analogous computations are thought to be egocentric (or route-based) in which no cognitive map is used to reach a goal location.

**Transportation:** (~Transportation Geography) Mobility of people, freight, and information and its spatial organization considering attributes and constraints related to the origin, destination, extent, nature, and purpose of movements.

**Travel behaviour:** The complicated decision-making process of travellers during a trip, regarding travel mode choice, route choice, departure time, destination choice, etc.

**Travel patterns:** A combination of the destinations an individual or individuals choose to visit, the order they choose to visit them in, and why they make these decisions.

**Trips:** A measurement of all travel in and out of a defined area.

**Walkability:** (~Walkable Community) Communities where goods (such as housing, offices, and retail) and services (such as transportation, schools, and libraries) that a community resident or employee needs on a regular basis are located within an easy and safe walk. Walkable communities facilitate pedestrian activity, expanding transportation options, and creating a streetscape that better serves a range of users -- pedestrians, bicyclists, transit riders, and automobiles. To foster walkability, communities typically mix land uses and build compactly, and ensure safe and inviting pedestrian corridors.
3.1.4 Uncategorised

**Policy**: A statement of a public body that forms the basis for enacting legislation or making decisions.

**Spatial**: Relating to, occupying, or having the character of space.

**Sustain**: (~Sustainability/Sustainable) To keep up or keep going, to maintain an action or process.

3.2 Terms for Health and Public Health

**Accidents**: In a chain of events, each of which is planned or controlled, an accident occurs as an unplanned event which, being the result of some non-adjustive act on the part of the individual or the environment (change in the physical, chemical, or biological characteristics of the air, water, or soil), may or may not result in an injury that can affect the health, survival, or activities of one or more forms of life in an unwanted way.

**Acclimation**: Physiological, anatomical, or morphological adjustments within a single organism that improve performance or survival in response to environmental change adjustment by an organism to environmental change (new temperature, altitude, climate, environment, or situation).

**Active ageing**: The process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age.

**Activities of daily living (ADL)**: A concept of functioning – activities of daily living are basic activities that are necessary to independent living, including eating, bathing and toileting. This concept has several assessment tools to determine an individual’s ability to perform the activity with or without assistance.

**Acute care / acute health care**: Care that is generally provided for a short period of time to treat a new illness or a flare-up of an existing condition. This type of care may include treatment at home, short-term hospital stays, professional care, surgery, X-rays and scans, as well as emergency medical services.

**Acute disease / illness**: A disease which is characterized by a single or repeated episode of relatively rapid onset and short duration from which the patient usually returns to his/her normal or previous state or level of activity. An acute episode of a chronic disease (for example, an episode of diabetic coma in a patient with diabetes) is often treated as an acute disease.
Adverse event / reaction: Any undesirable or unwanted consequence of a preventive, diagnostic or therapeutic procedure.

Ageing: The lifelong process of growing older at cellular, organ or whole-body level throughout the life span.

Ageing / aging in place: Meeting the desire and ability of people, through the provision of appropriate services and assistance, to remain living relatively independently in the community in his or her current home or an appropriate level of housing. Ageing in place is designed to prevent or delay more traumatic moves-to a dependent facility, such as a nursing home.

Aid An item, such as a walking frame or a shower chair, which helps people to manage the activities of daily living.

Alternative and complementary health care / medicine / therapies: Health care practices that are not currently an integral part of conventional medicine. The list of these practices changes over time as the practices and therapies are proven safe and effective and become accepted as mainstream health care practices. These unorthodox approaches to health care are not based on biomedical explanations for their effectiveness. Examples include homeopathy, herbal formulas, and use of other natural products as preventive and treatment agents.

Ambulatory care: Health services provided on an outpatient basis in contrast to services provided in the home or to persons who are inpatients. While many inpatients may be ambulatory, the term ambulatory care usually implies the patient travels to a location to receive services and no overnight stay in hospital is required. Many surgeries and treatments are now provided on an outpatient basis, while previously they were considered reason for inpatient hospitalization.

Autonomy: The perceived ability to control, cope with and make personal decisions about how one lives on a daily basis, according to one’s own rules and preferences.

Birth rate: (~Crude Birth Rate) The ratio between the number of live births in a population during a given year and the total mid-year population for the same year, usually multiplied by 1,000.

Burden of disease - The burden of disease is a measurement of the gap between a population's current health and the optimal state where all people attain full life expectancy without suffering major ill-health. Burden of disease analysis enables decision-makers to identify the most serious health problems facing a population. Loss
of health in populations is measured in disability-adjusted life years (DALYs), which is the sum of years of life lost due to premature death and years lived with disability. Burden of disease data provide a basis for determining the relative contribution of various risk factors to population health that can be used in health promotion priority setting.

**Cancer:** A large group of diseases that can start in almost any organ or tissue of the body when abnormal cells grow uncontrollably, go beyond their usual boundaries to invade adjoining parts of the body and/or spread to other organs. The latter process is called metastasizing and is a major cause of death from cancer. A neoplasm and malignant tumour are other common names for cancer. Cancer is the second leading cause of death globally, accounting for an estimated 9.6 million deaths, or one in six deaths, in 2018. Lung, prostate, colorectal, stomach and liver cancer are the most common types of cancer in men, while breast, colorectal, lung, cervical and thyroid cancer are the most common among women.

**Cardiovascular disease (CVD):** It is the name for the group of disorders of heart and blood vessels and include hypertension (high blood pressure); coronary heart disease (heart attack); cerebrovascular disease (stroke); peripheral vascular disease; heart failure; rheumatic heart disease; congenital heart disease; cardiomyopathies. CVDs are the number one cause of death globally: more people die annually from CVDs than from any other cause.

**Care:** The application of knowledge to the benefit of a community or individual. There are various levels of care: (a) intermediate care, short period of intensive rehabilitation and treatment to enable people to return home following hospitalization or to prevent admission to hospital or residential care; (b) primary care, basic or general health care focused on the point at which a patient ideally first seeks assistance from the medical care system. It is the basis for referrals to secondary and tertiary level care; (c) secondary care, specialist care provided on an ambulatory or inpatient basis, usually following a referral from primary care; (d) tertiary care, the provision of highly specialized services in ambulatory and hospital settings. It could also be seen as the responsibility for or attention to health, well-being, and safety.

**Caregiver:** A person who provides support and assistance, formal or informal, with various activities to persons with disabilities or long-term conditions, or persons who are elderly. This person may provide emotional or financial support, as well as hands-on help with different tasks. Caregiving may also be done from long distance.
**Case control study:** A study in which people with a disease (cases) are compared to people without the disease (controls) to see if their past exposures to chemicals or other risk factors were different.

**Catchment area:** A geographic area defined and served by a health programme or institution, such as a hospital or community health centre, which is delineated on the basis of such factors as population distribution, natural geographic boundaries, and transportation accessibility. By definition, all residents of the area needing the services of the programme are usually eligible for them, although eligibility may also depend on additional criteria.

**Cause of death:** For the purpose of national mortality statistics, every death is attributed to one underlying condition, based on information reported on the death certificate and using the international rules for selecting the underlying cause of death from the reported conditions.

**Chronic condition (disease):** A disease which has one or more of the following characteristics: is permanent; leaves residual disability; is caused by non-reversible pathological alternation; requires special training of the patient for rehabilitation; or may be expected to require a long period of supervision, observation or care.

**Clinical condition:** A diagnosis (e.g., myocardial infarct) or a patient state that may be associated with more than one diagnosis (such as paraplegia) or that may be as yet undiagnosed (such as low back pain).

**Clinical observation:** Clinical information, excluding information about treatment and intervention. Clinical information that does not record an intervention is by nature a clinical observation. The observer may be the patient or related person (information about symptoms, family history, occupation or lifestyle) or a health care professional (information about physical signs, measurements, properties observed or diagnoses). While information about the nature of a planned or performed treatment is excluded by the definition, clinical observations may be recorded on the results of a treatment, on progress during the course of a treatment, or on the result of a treatment.

**Clinical significance:** A conclusion that an intervention has an effect that is of practical meaning to older persons and health care providers. Even though an intervention is found to have a statistically significant effect, this effect may not be clinically significant. In a trial with a large number of participants, a small difference between treatment and control groups may be statistically significant, but clinically unimportant. In a trial with few participants, an important clinical difference may be observed that does not achieve
statistical significance. (A larger trial may be needed to confirm that this is a statistically significant difference).

**Clinical trial:** A controlled research study of the safety and effectiveness of drugs, devices or techniques that occurs in four phases, starting with the enrolment of a small number of people, to the later stages in which thousands of people are involved prior to approval by the licensing authorities (for example, the Food and Drug Administration).

**Cohort:** A set of people born during a specific time period; also, a set of people born during a historical era that creates different inter-cohort characteristics such as size, composition, experiences and values. The term “cohort” has been broadened to describe any designated group of persons who are followed or traced over a period of time.

**Community-based care / community-based services / programmes:** The blend of health and social services provided to an individual or family in his/her place of residence for the purpose of promoting, maintaining or restoring health or minimizing the effects of illness and disability. These services are usually designed to help older people remain independent and in their own homes. They can include senior centres, transportation, delivered meals or congregate meals sites, visiting nurses or home health aides, adult day care and homemaker services.

**Community health:** The combination of sciences, skills and beliefs directed towards the maintenance and improvement of the health of all the people through collective or social actions. The programmes, services and institutions involved emphasize the prevention of disease and the health needs of the population as a whole. Community health activities change with changing technology and social values, but the goals remain the same.

**Co-morbid condition:** Conditions that exist at the same time as the primary condition in the same patient (e.g., hypertension is a co-morbidity of many conditions, such as diabetes, ischemic heart disease, end-stage renal disease, etc.). Two or more conditions may interact in such a way as to prolong a stay in hospital or hinder successful rehabilitation.

**Contraindication:** A clinical symptom, circumstance, condition indicating that the use of an otherwise advisable intervention would be inappropriate. A contraindication may be absolute or relative. An absolute contraindication is a situation which makes a particular treatment or procedure absolutely inadvisable. A relative contraindication is a condition which makes a particular treatment or procedure somewhat inadvisable, but does not rule it out (for example, X-rays in pregnancy).
**Coping:** An adaptive or otherwise successful method of dealing with individual or environmental situations that involve psychological and physiological stress or threat.

**Core activities:** Activities which are essential for daily living, such as self-care, mobility and communication.

**Demography:** The study of populations, especially with reference to size and density, fertility, mortality, growth, age distribution, migration and vital statistics, and the interaction of all of these with social and economic conditions.

**Dependency** Reliance on others to provide physical, mental and/or social support.

**Determinants of health:** The range of personal, social, economic and environmental factors which determine the health status of individuals or populations. The factors which influence health are multiple and interactive. Some determinants of health are not modifiable (for example age, sex and genetic endowment).

**Diagnosis** The process of determining health status and the factors responsible for producing it. It may be applied to an individual, family, group or community. The term is applied both to the process of determination and to its findings.

**Disability:** Any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner, or within the range, considered to be normal for a human being. The term disability reflects the consequences of impairment in terms of functional performance and activity by the individual. Disabilities thus represent disturbances at the level of the person.

**Disease / Disorder:** A failure of the adaptive mechanisms of an organism to counteract adequately, normally or appropriately to stimuli and stresses to which the organism is subjected, resulting in a disturbance in the function or structure of some part of the organism that can result in diminished quality of life. This definition emphasizes that disease is multifactorial and may be prevented or treated by changing any or a combination of the factors. Disease is a very elusive and difficult concept to define, being largely socially defined. Thus, criminality and drug dependence are presently seen by some as diseases, when they were previously considered to be moral or legal problems.

**e-health:** An emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies.

**Emergency:** A sudden unexpected onset of illness or injury which requires immediate care.
Endemic: Prevalent in or peculiar to a particular locality or people.

Endpoint: A measure or indicator chosen for determining an effect of an intervention.

Epidemic: The occurrence of more cases of disease than expected within a population in a geographic area over a set period of time. There is no absolute criterion for using the term epidemic; as standards and expectations change, so might the definition of an epidemic, such as an epidemic of violence.

Epidemiology: Is the study of the distribution and determinants of health-states or events in specified populations, and the application of this study to the control of health problems. Epidemiological information, particularly that defining individual, population and/or physical environmental risks has been at the core of public health and provided the basis for disease prevention activities. Epidemiological studies use social classifications (such as socioeconomic status) in the study of disease in populations, but generally make less than optimal use of social sciences, including economic and public policy information, in investigating and understanding disease and health in populations.

Equality: The principle by which all persons or things under consideration are treated in the same way.

Etiology / etiologic: Causes or causality, usually applying to disease.

Evidence-Based Medicine: It is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. This approach must balance the best external evidence with the desires of the patient and the clinical expertise of health care providers.

Fertility rate (Total fertility rate): The expected average number of children that would be born to a woman in her lifetime, if she were to pass through her childbearing years experiencing the age-specific fertility rates prevailing in a given year/period, for a given country, territory, or geographic area.

Functional status: The extent to which an individual is able to perform activities that are associated with the routines of daily living.

Functionally disabled: A person with a physical or mental impairment that limits the individual's capacity for independent living.

Geriatric medicine: The branch of medicine specializing in the health and illnesses of old age and the appropriate care and services.

Gerontology: The multidisciplinary study of all aspects of ageing, including health, biological, sociological, psychological, economic, behavioural and environmental factors.
Global health: Refers to the transnational impacts of globalization upon health determinants and health problems which are the beyond the control of individual nations. Issues on the global health agenda include the inequities caused by patterns of international trade and investment, the effects of global climate change, the vulnerability of refugee populations, the marketing of harmful products by transnational corporations and the transmission of diseases resulting from travel between countries.

Handicap: A disadvantage for a given individual, resulting from an impairment or a disability that limits or prevents the fulfilment of a role that is normal (depending on age, sex and social and cultural practice) for that individual. The term handicap thus reflects interaction with, and adaptation to, the individual’s surroundings.

Hazard (health) A factor or exposure that may adversely affect health.

Health: A state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity. It is regarded by WHO as a fundamental human right and, correspondingly, all people should have access to basic resources for health. Within the context of health promotion, health has been considered less as an abstract state and more as a means to an end which can be expressed in functional terms as a resource which permits people to lead an individually, socially and economically productive life: “Health is a resource for everyday life, not the object of living. It is a positive concept emphasizing social and personal resources as well as physical capabilities.”

Health behaviour: Any activity undertaken by an individual, regardless of actual or perceived health status, for the purpose of promoting, protecting or maintaining health, whether or not such behaviour is objectively effective towards that end. It is possible to argue that almost every behaviour or activity by an individual has an impact on health status. In this context it is useful to distinguish between behaviours which are purposefully adopted to promote or protect health (as in the definition above), and those which may be adopted regardless of consequences to health. By contrast, an unhealthy behaviour is a patterned behaviour that is harmful to physical or mental health.

Health impact assessment: Is a combination of procedures, methods and tools by which a policy, program, product, or service may be judged concerning its effects on the health of the population. It is usually conducted at the local or regional level, and its primary purpose is to inform the development of policies and programs that will promote better health and reduce health inequalities.
Health indicator: Is a characteristic of an individual, population, or environment which is subject to measurement (directly or indirectly) and can be used to describe one or more aspects of the health of an individual or population (quality, quantity and time). Health indicators can be used to define public health problems at a particular point in time, to indicate change over time in the level of the health of a population or individual, to define differences in the health of populations, and to assess the extent to which the objectives of a programme are being reached.

Health outcomes: A change in the health status of an individual, group or population which is attributable to a planned intervention or series of interventions, regardless of whether such an intervention was intended to change health status. Such a definition emphasizes the outcome of planned interventions (as opposed, for example, to incidental exposure to risk), and that outcomes may be for individuals, groups or whole populations. Interventions may include government policies and consequent programmes, laws and regulations, or health services and programmes, including health promotion programmes. They may also include the intended or unintended health outcomes of government policies in sectors other than health. Health outcomes will normally be assessed using health indicators.

Health promotion: Is the process of enabling people to increase control over, and to improve their health.

Health status: A description and/or measurement of the health of an individual or population at a particular point in time against identifiable standards, usually by reference to health indicators.

Healthy ageing: An approach which recognizes that growing older is a part of living; recognizes the interdependence of generations; recognizes that everyone has a responsibility to be fair in their demands on other generations; fosters a positive attitude throughout life to growing older; eliminates age as a reason to exclude any person from participating fully in community life; promotes a commitment to activities which enhance well-being and health, choice and independence, and quality of life for all ages; encourages communities to value and listen to older people and to cater for the diverse preferences, motivations, characteristics and circumstances of older persons in a variety of ways.

Healthy Cities: A healthy city is one that is continually creating and improving those physical and social environments and expanding those community resources which
enable people to mutually support each other in performing all the functions of life and in developing to their maximum potential.

**Homebound / housebound:** Generally unable to leave the house, or only for a short time.

**Hospital** An institution the primary function of which is to provide inpatient diagnostic and therapeutic services for a variety of medical conditions, both surgical and nonsurgical. Most hospitals provide some outpatient services, particularly emergency care.

**Host** A person or other living animal that affords subsistence or lodgement to an infectious agent under natural conditions; in an epidemiologic context, the host may be the population or group, or biological, social and behavioural characteristics of the group.

**General hospital** A hospital providing a variety of services, including medicine and surgery, to meet the general medical needs of the community it serves.

**General practice** A form of practice in which medical practitioners provide a wide range of primary health care services to people.

**Generation effect** Variations in health status that arise from the different causal factors to which each birth cohort in the population is exposed as the environment and society change. Each consecutive birth cohort is exposed to a unique environment that coincides with its life span.

**Iatrogenic illness (or injury):** Negative effect resulting from a medical treatment.

**Illness:** A person's own perceptions, experience and evaluation of a disease or condition, or how he or she feels. For example, an individual may feel pain, discomfort, weakness, depression or anxiety, but a disease may or may not be present.

**Impairment:** Any loss or abnormality of psychological, physiological or anatomical structure or function. It is concerned with abnormalities of body structure and appearance, organ or system resulting from any cause. In principle, impairments represent disturbances at the organ level.

**Incidence:** The number of cases of disease that have their onset during a prescribed period of time. It is often expressed as a rate. Incidence is a measure of morbidity or other events that occur within a specified period of time. See related prevalence.

**Independence:** The ability to perform an activity with no or little help from others, including having control over any assistance required rather than the physical capacity to do everything oneself.
Independent living: Living at home without the need for continuous help and with a degree of self-determination or control over one's activities.

Infant mortality rate: The quotient between the number of deaths in children under 1 year of age in a given year and the number of live births in that year, for a given country, territory, or geographic area, expressed per 1,000 live births, as reported from the national health authority. The reported neonatal mortality rate is defined as the quotient between the number of children born alive that died before the age of 28 days in a given year and the number of live births in that year, for a given country, territory, or geographic area, expressed per 1,000 live births, as reported from the national health authority. The reported post neonatal mortality rate is defined as the quotient between the number of children that were alive after 27 days of age and died before the age of 1 year in a given year and the number of live births in that year, for a given country, territory, or geographic area, expressed per 1,000 live births, as reported from the national health authority.

Infection: The growth of harmful organisms that can cause disease, such as bacteria, in the body.

Infectious: Capable of causing infection or disease by entrance of organisms (e.g., bacteria, viruses, protozoan, fungi) into the body, which then grow and multiply. Often used synonymously with “communicable”.

Inpatient: An individual who has been admitted to a hospital or other facility for diagnosis and/or treatment that requires at least an overnight stay.

Instrumental activities of daily living (IADL): Activities with aspects of cognitive and social functioning, including shopping, cooking, doing housework, managing money and using the telephone.

International Statistical Classification of Diseases and Related Health Problems: A list of diagnoses and identifying codes used by medical practitioners and other health care providers. The coding and terminology provide a uniform language that permits consistent communication on claim forms. Data from earlier time periods were coded using the appropriate revision of the ICD for that time period. Changes in classification of causes of death in successive revisions of the ICD may introduce discontinuities in cause of death statistics over time.

Intervention / intervention strategy: An activity or set of activities aimed at modifying a process, course of action or sequence of events in order to change one or several of their characteristics, such as performance or expected outcome. For example, it is used
in public health to describe a programme or policy designed to have an impact on an illness or disease.

**Isolation:** The separation, or the period of communicability, of known infected people in such places and under such condition as to prevent or limit the transmission of the infectious agent.

**Injury:** damage to the body produced by energy exchanges that have relatively sudden discernible effects.

**Injured:** Any person who was not killed but sustained one or more serious or slight injuries as a result of the accident.

**Life expectancy:** The average number of years of life remaining to a person at a particular age based on a given set of age-specific death rates, generally the mortality conditions existing in the period mentioned.

**Life span:** The longest period over which the life of any plant or animal organism or species may extend, according to the available biological knowledge concerning it.

**Lifestyle:** The set of habits and customs that is influenced, modified, encouraged or constrained by the interplay between an individual's personal characteristics, social interactions, and socioeconomic and environmental living conditions. These habits and customs include the use of substances, such as alcohol, tobacco, tea or coffee; dietary habits; and exercise. They have important implications for health and are often the subject of epidemiological investigation.

**Medical record** A file kept for each patient, maintained by the hospital (medical practitioners also maintain medical records in their own practices), which documents the patient's problems, diagnostic procedures, treatment and outcome. Related documents, such as written consent for surgery and other procedures, are also included in the record. In addition to facts about a patient's illness, medical records nearly always contain other information such as clinical, demographic, sociocultural, sociological, economic, administrative and behavioural data. The record may be on paper or computerized.

**Morbidity** Any departure, subjective or objective, from a state of physiological or psychological well-being. In this sense, sickness, illness and morbid conditions are similarly defined and synonymous.

**Mortality:** Death. Used to describe the relation of deaths to the population in which they occur. Estimated general mortality rate is the total number of deaths in a population of a
given sex and/or age, divided by the total number of this population, expressed per 1,000 population, for a given year, in a given country, territory, or geographic area.

**Neglect**: The refusal or failure on the part of a person (or persons) in a caring role to fulfil a care-giving obligation, either consciously or unintentionally, which results in physical or emotional distress (e.g., for an older person).

**Non-infectious**: Not spread by infectious agents. Often used synonymously with “non-communicable”.

**Nutrition**: (1) The process of nourishing or being nourished, especially the process by which a living organism assimilates food and uses it for growth and for replacement of tissues. (2) The science or study that deals with food and nourishment, especially in humans.

**Occupational therapy**: Therapy designed to help individuals improve their independence in daily living activities through rehabilitation, exercises and the use of assistive devices. In addition, such therapy provides activities to promote growth, self-fulfilment and self-esteem.

**Outcome**: This term has many meanings depending on its applicability. Simply an outcome is a change in a situation resulting from an action. More specifically, in relation to health, an outcome is the possible results that may stem from exposure to a causal factor; or the result of preventive, medical, surgical or therapeutic interventions or non-intervention. An outcome can also be viewed as the end result obtained from utilizing the structure and processes of health care delivery. Outcomes are often viewed as the bottom-line measure of the effectiveness of the health care delivery system.

**Outcome measurement**: System used to track treatment or care and responses. The methods for measuring outcomes are quite varied among providers. Much disagreement exists regarding the best practice or tools to utilize to measure outcomes.

**Outpatient**: A patient who is receiving ambulatory care at a hospital or other facility without being admitted to the facility.

**Pain**: An unpleasant sensory or emotional experience that is derived from sensory stimuli and modified by individual memory, expectations and emotions.

**Pandemia** (~Pandemic) An epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people. The classical definition includes nothing about population immunity, virology or disease severity. By this definition, pandemics can be said to occur annually in each of the
temperate southern and northern hemispheres, given that seasonal epidemics cross international boundaries and affect a large number of people. However, seasonal epidemics are not considered pandemics.

**Pathogen:** Any agent that causes disease, especially a microorganism such as bacterium or fungus.

**Pathological:** Indicative of, or caused by, a disease or condition.

**Patient:** A person in contact with the health system seeking attention for a health condition.

**Personal care:** Assistance with those functions and activities normally associated with body hygiene, nutrition, elimination, rest and ambulation, which enables an individual to live at home or in the community.

**Pharmacy:** (1) The art or practice of preparing and preserving drugs, and of compounding and dispensing medicines according to the prescriptions of medical practitioners. (2) A place where drugs are dispensed.

**Physical activity:** Any form of exercise or movement and that usually requires energy expenditure.

**Physical therapy / Physiotherapy:** (1) Treatment of pain, disease or injury by physical means. (2) The profession concerned with promotion of health; prevention of physical disabilities; evaluation and rehabilitation of persons disabled by pain, disease or injury; and with treatment by physical therapeutic measures, as opposed to medical, surgical or radiologic measures.

**Physician:** Professional person qualified by education and authorised by law to practise medicine. In certain countries refers to a specialist in internal medicine.

**Placebo:** Any dummy medical treatment or intervention. Originally, a medicinal preparation having no specific pharmacological activity against the person's illness or complaint and given solely for the psychophysiological effects of the treatment. More recently, a dummy treatment administered to the control group in a controlled clinical trial in order that the specific and non-specific effects of the experimental treatment can be distinguished.

**Polypharmacy:** (1) The administration of many drugs at the same time. (2) The administration of an excessive number of drugs.

**Population:** A group of individuals or items that share one or more characteristics from which data can be gathered and analysed.
Population ageing: The increase over time in the proportion of the population of a specified older age.

Population-based services: Health services targeted at populations with specific diseases or disorders.

Population dynamics: The study of changes in the number and composition of individuals in a population and the factors that influence those changes. Population dynamics involves five basic components of interest, to which all changes in populations can be related: birth, death, sex ratio, age structure and dispersal.

Positive health: A state of health beyond an asymptomatic state. It usually includes the quality of life and the potential of the human condition. It may also include self-fulfilment, vitality for living and creativity. It is concerned with thriving rather than merely coping.

Pre-existing condition: A term normally used for a condition developed prior to applying for a health insurance policy. Some policies exclude coverage of such conditions for a period of time or indefinitely.

Prevalence: The number of cases of a disease, infected people or people with some other attribute present during a particular interval of time. It often is expressed as a rate.

Prevention: This is aimed at promoting health, preserving health and restoring health when it is impaired and to minimize suffering and distress. There are various levels of prevention: primordial prevention, actions and measures that inhibit the emergence and establishment of environmental, economic, social and behavioural conditions, cultural patterns of living, etc., known to increase the risk of disease; primary prevention, the protection of health by personal and community-wide effects and it involves measures provided to individuals to prevent the onset of a targeted condition; secondary prevention, measures that identify and treat asymptomatic persons who have already developed risk factors or preclinical disease, but in whom the condition is not clinically apparent. These activities are focused on early case-finding of asymptomatic disease that occurs commonly and has significant risk for negative outcome without treatment; tertiary prevention, a process aimed at limiting the negative effects of an established disease.

Primary health care: It is essential health care made accessible at a cost a country and community can afford, with methods that are practical, scientifically sound and socially acceptable.
Protection: Elimination or reduction of exposure to injuries and occupational or environmental hazards.

Protective factor: An aspect of life that reduces the likelihood of negative outcomes, either directly or by reducing the effects of risk factors.

Public health: The approach to health that is concerned with the health of the community as a whole. The three core public health functions are: the assessment and monitoring of the health of communities and populations at risk to identify health problems and priorities; the formulation of public policies designed to solve identified local and national health problems and priorities; and ensuring that all populations have access to appropriate and cost-effective care, including health promotion and disease prevention services, and evaluation of the effectiveness of that care.

Quality of life: The product of the interplay between social, health, economic and environmental conditions which affect human and social development. It is a broad-ranging concept, incorporating a person’s physical health, psychological state, level of independence, social relationships, personal beliefs and relationship to salient features in the environment. As people age, their quality of life is largely determined by their ability to access needed resources and maintain autonomy and independence.

Quarantine: The restriction of the activities of healthy people who have been exposed to a communicable disease, during its period of communicability, to prevent disease transmission during the incubation period should infection occur.

Rehabilitation: A proactive and goal-oriented activity to restore function and/or to maximize remaining function to bring about the highest possible level of independence, physically, psychologically, socially and economically. It involves combined and coordinated use of medical, nursing and allied health skills, along with social, educational and vocational services, to provide individual assessment, treatment, regular review, discharge planning and follow-up. Rehabilitation is concerned, not only with physical recovery, but also with psychological and social recovery and reintegration (or integration) of the person into the community.

Risk assessment: Identifying and measuring the presence of direct causes and risk factors that, based on scientific evidence or theory, are thought to directly influence the level of a specific health problem.

Risk behaviour: Specific forms of behaviour which are proven to be associated with increased susceptibility to a specific disease or ill-health. Changes in risk behaviour are
major goals of disease prevention, and traditionally health education has been used to achieving these goals.

**Risk factor:** Personal qualities or societal conditions that lead to the increased probability of a problem or problems developing.

**Road traffic accident:** An accident which occurred or originated on a way or street open to public traffic; resulted in one or more persons being killed or injured, and at least one moving vehicle was involved. These accidents therefore include collisions between vehicles, between vehicles and pedestrians and between vehicles and animals or fixed obstacles. Single vehicle accidents in which one vehicle alone (and no other road user) was involved are included. Multi-vehicle collisions are counted only as one accident provided that the successive collisions happened at very short intervals.

**Safety:** A judgment of the acceptability of risk (a measure of the probability of an adverse outcome and its severity) associated with a given situation or setting.

**Screening:** The use of procedures and measures to identify and differentiate apparently well persons who have a disease or condition or a high risk thereof from those who probably do not have the disease or condition.

**Self-care:** Health activities, including promotion, maintenance, treatment, care and health related decision-making, carried out by individuals and families.

**Self-reliance / self-sufficiency / self-management:** The capacity of individuals, communities or national authorities to take the initiative in assuming responsibility for their own health development and adopting adequate measures to maintain health that are understood by them and acceptable to them, knowing their own strengths and resources and how to use them and knowing when, and for what purpose, to turn to others for support and cooperation.

**Side-effect:** An effect, other than the intended one, produced by a preventive, diagnostic or therapeutic procedure or regimen.

**Smoking:** The act of inhaling and exhaling any tobacco product (products entirely or partly made of the leaf tobacco as raw material which are manufactured to be used for smoking, sucking, chewing or snuffing), either daily or occasionally. A smoker is someone who smokes any tobacco product, either daily or occasionally. A daily smoker is someone who smokes any tobacco product at least once a day. An occasional smoker is someone who smokes, but not every day. A "tobacco user" is someone who uses any tobacco product.
Social care service: Assistance with the activities of daily life (personal care, domestic maintenance, self-direction) delivered by a personal care helper, home helper or social worker and aimed at supporting older people who experience disabilities in functioning.

Social determinants of health: Social determinants of health refer to both specific features of and pathways by which societal conditions affect health and that potentially can be altered by informed action. As determinants, these social processes and conditions are conceptualised as “essential factors” that “set certain limits or exert pressures”, albeit without necessarily being “deterministic” in the sense of “fatalistic determinism.” Historically contingent, social determinants of health, broadly writ, include: (a) a society’s past and present economic, political, and legal systems, its material and technological resources, and its adherence to norms and practices consistent with international human rights norms and standards; and (b) its external political and economic relationships to other countries, as implemented through interactions among governments, international political and economic.

Social support: That assistance available to individuals and groups from within communities which can provide a buffer against adverse life events and living conditions and can provide a positive resource for enhancing the quality of life. Social support may include emotional support, information sharing and the provision of material resources and services. Social support is now widely recognized as an important determinant of health, and an essential element of social capital.

Specialist: A health professional who is specially trained in a certain branch of his/her profession related to specific services or procedures.

Stress: A term widely used in the biological, physical, and social sciences, is a construct whose meaning in health research is variously defined in relationship to “stressful events, responses, and individual appraisals of situations”. Common to these definitions is “an interest in the process in which environmental demands tax or exceed the adaptive capacity of an organism, resulting in psychological or biological changes that may place persons at risk for disease”. It is also viewed as an innate survival response in which certain hormones are released, increasing blood flow to the brain or heart. The stress response leads to an energy surge, enabling a person to flee dangerous situations. Ongoing stress, however, can sap energy and damage health.

Symptom: A sign or indication of disorder or disease, especially when experienced by an individual as a change in normal function, sensation or appearance.
Targeting / target population / target group: The group of persons for whom an intervention is planned. For example, the targeting of services to particular user groups.

Telemedicine / telehealth: The employment of communication technology to provide assistance in the diagnosis, treatment, care and management of health conditions in remote areas. It is more focused on patient delivery and linked to medical professionals than e-Health.

Terminal illness: An illness for which there is no known cure.

Treatment: A process designed to achieve a desired health status for a patient or client.

Urgent condition: A condition requiring medical attention within a few hours; a longer delay presents possible danger to the individual; and the disorder is acute but not necessarily severe.

Vector: In infectious disease epidemiology, an insect or any living carrier that transports an infectious agent from an infected individual or its wastes to a susceptible individual or its food or immediate surroundings.

Vital signs: The pulse, respiration, temperature and blood pressure.

Well-being / Wellbeing: A dynamic state of physical, mental and social wellness; a way of life which equips the individual to realize the full potential of his/her capabilities and to overcome and compensate for weaknesses; a lifestyle which recognizes the importance of nutrition, physical fitness, stress reduction, and self-responsibility. Well-being has been viewed as the result of four key factors over which an individual has varying degrees of control: human biology, social and physical environment, health care organization (system), and lifestyle.

Wellness: Wellness is the optimal state of health of individuals and groups. There are two focal concerns: the realization of the fullest potential of an individual physically, psychologically, socially, spiritually and economically, and the fulfilment of one’s role expectations in the family, community, place of worship, workplace and other settings. It can also be seen as the active pursuit of activities, choices and lifestyles that lead to a state of holistic health.
Chapter 4

Neuroscience: cognition and emotion - Glossary

This glossary includes a selection of terms pertaining to the field of research in Neuroscience. It provides definitions, some of them not particularly technical but that should be part of the know-how of eMOTIONAL Cities researchers, for the key concepts and terms of general neuroscience, cognition and emotion. Furthermore, it also includes a section on mental health.

4.1 General Neuroscience

4.1.1 Neuron and neural system

**Acetylcholine**: An excitatory neurotransmitter whose many functions include arousal, muscle activation, memory, and attention.

**Action potential**: The electrical signal conducted along neuronal axons by which information is conveyed from one place to another in the nervous system.

**Activation**: The time-dependent opening of ion channels in response to a stimulus, typically membrane depolarization.

**Acuity**: The ability of a sensory system to accurately discriminate spatial detail; usually tested by the ability to spatially discriminate two points, as in the Snellen eye chart exam for vision. Applies to all the sensory systems, but most obviously to vision and somatic sensation.

**Adaptation**: The phenomenon of sensory receptor adjustment to different levels of stimulation; critical for allowing sensory systems to operate over a wide dynamic range.

**Adrenal medulla**: The central part of the adrenal gland that, under visceral motor stimulation, secretes epinephrine and norepinephrine into the bloodstream.

**Afferent neuron**: An axon that conducts action potentials from the periphery to more central parts of the nervous system.

**Adrenaline (or epinephrine)**: A catecholaminergic neurotransmitter and hormone involved in many body functions, including the fight-or-flight response coordinated by the autonomic nervous system.

**Agonist**: A neuropharmacological agent that mimics the action of a neurotransmitter.

**Antagonist**: A neuropharmacological agent that opposes or interferes with the action of a neurotransmitter.
**Associativity:** In long-term potentiation, the enhancement of a weakly activated group of synapses when a nearby group is strongly activated.

**Astrocytes:** One of the three major classes of glial cells found in the central nervous system; important in regulating the ionic milieu of nerve cells and, in some cases, transmitter reuptake.

**Atrophy:** The physical wasting away of a tissue, typically muscle, in response to disuse or other causes.

**Autonomic nervous system (ANS):** The components of the nervous system (peripheral and central) concerned with the regulation of basic functions of metabolism and survival. Also known as the visceral motor system as it is dedicated to proper functioning of the viscera (all the organs – including smooth muscle, cardiac muscle, and glands, that maintain the wellbeing of the body and the brain); sometimes called the "involuntary" nervous system. Consists of sympathetic and parasympathetic divisions.

**Axon:** The extension from the soma across which electrical impulses are sent to the dendrites at its tip.

**Baroreceptors** Sensory receptors in the visceral motor system that respond to changes in blood pressure.

**Blood–brain barrier:** A diffusion barrier between the brain vasculature and the substance of the brain formed by tight junctions between capillary endothelial cells.

**Carotid bodies** Specialized tissue masses found at the bifurcation of the carotid arteries in humans and other mammals that respond to the chemical composition of the blood (primarily the partial pressure of oxygen and carbon dioxide).

**Catecholamine:** A term referring to molecules containing a catechol ring and an amino group; examples are the neurotransmitters epinephrine, norepinephrine, and dopamine.

**Cell:** The basic biological unit of life, defined by a membrane or wall that encloses cytoplasm and, in eukaryote organisms (including all plants and animals), a nucleus.

**Cell body:** Also called soma. The portion of a neuron that houses the cell's nucleus; axons and dendrites typically extend from the neuronal cell body.

**Central nervous system:** The brain and spinal cord.

**Cerebrospinal fluid:** A normally clear and cell-free fluid that fills the ventricular system of the central nervous system; produced by the choroid plexus in the lateral ventricles.
**Chemical synapse:** A synapse that uses a chemical transmitter agent; the most common type of synapse in the mammalian brain.

**Cholinergic:** Referring to synaptic transmission mediated by acetylcholine.

**Circadian rhythms:** Variations in physiological functions that occur on a daily basis.

**Coactivation:** Two areas of the brain are said to be coactivated if they both show higher activity in a specific task. Statistically, coactivation is reflected by a positive correlation of activity between two areas.

**Coma:** A pathological state of profound and persistent unconsciousness.

**Cortical modules:** Also called cortical columns. Vertically organized groups of cortical neurons that process the same or similar information; examples are ocular dominance columns and orientation columns in the primary visual cortex.

**Cortisol:** A steroidal hormone (and glucocorticoid) released in response to stress to enhance flight-flight processes. Cortisol inhibits protein synthesis, increases blood sugar, and suppresses immunological functioning in the service of immediate survival needs.

**Cranial nerves:** The 14 central nerves that connect the brain with the rest of the body. These nerves project from the cranial motor nuclei to sense organs or muscles, mostly of the face, head, eyes, or neck.

**Critical period:** A restricted developmental period during which the nervous system is particularly sensitive to the effects of experience.

**Dendrite:** Ending point of the axon that connects with other neurons via chemical messengers called neurotransmitters.

**Disinhibition:** Arrangement of inhibitory and excitatory cells in a circuit that generates excitation by the transient inhibition of a tonically active inhibitory neuron.

**Dopamine:** A catecholamine neurotransmitter that primarily serves neural networks involved in learning, motivation and motor control. The dopaminergic neurons, which are mostly located in the ventral tegmental area of the midbrain, the substantia nigra pars compacta, and the hypothalamus, have been particularly associated with reward evaluation.

**Effector:** A muscle or gland that provides the output of neural processing.

**Efferent neuron:** An axon that conducts information away from the central nervous system.
**Electrical synapses:** Synapses that transmit information via the direct flow of electrical current at gap junctions.

**Enteric nervous system:** A branch of the ANS that controls the gastrointestinal tract via peristalsis and enzyme secretion.

**Excitatory:** Pertaining to a synaptic effect that brings the membrane of the postsynaptic cell closer to threshold, thereby making firing of the postsynaptic cell more likely.

**Fiber tract:** Bundles of axons in the brain that carry neuronal signals between brain areas.

**GABA (gamma aminobutyric acid):** The major inhibitory neurotransmitter in the central nervous system of mammals, also involved in muscle tone.

**Ganglion:** A cluster of neurons organized into functional units (plural, ganglia).

**Genotype and phenotype:** The genotype of an organism describes the genetic makeup of an individual while the phenotype describes observable characteristics. For example, an individual may have genes for both blue and brown eyes (genotype) but may express brown eyes (phenotype).

**Glia:** A variety of nonneuronal support cells (astrocytes, oligodendrocytes, and microglial cells in the central nervous system; Schwann cells in peripheral nerves; and satellite cells in ganglia) interwoven with neurons throughout the nervous system.

**Glutamate:** The most common excitatory neurotransmitter, it is known to play a key role in learning and long-term memory.

**Habituation:** The process by which a behavioural response to the same stimulus decreases in intensity, frequency, or duration when that stimulus is repeated over and over.

**Hebbian synapse:** The coordination of two neurons that leads them to tend to fire together, which assists learning. The idea, proposed by Donald Hebb in the late 1940s, that when presynaptic and postsynaptic neurons fire action potentials together, the strength of the synaptic connections between them is enhanced – Hebbian learning. Hebb’s rule is often state as “cells that fire together wire together.”

**Hyperpolarization:** Changing the membrane potential of a neuron in the negative direction, driving it away from threshold and making it less likely to initiate an action potential.
**Hypoxia:** Lack of oxygen in the brain. Can be local, usually created by diminished blood flow (ischemia) due to local vascular occlusions; or global deprivation of oxygen after an event such as drowning or cardiac arrest.

**Inhibitory:** Pertaining to a synaptic effect that makes the firing of the postsynaptic cell less likely.

**Input:** The innervation of a target cell by a particular axon; more loosely, the innervation of a target.

**Interneuron:** Also called local circuit neuron. Literally, a neuron in a circuit that lies between primary sensory and primary effector neurons; more generally, a neuron that branches locally to innervate other neurons.

**Ion channel:** A membrane protein that uses the passive energy of concentration gradients (created by ion pumps) to allow the passage of ions across the cell membrane.

**Ion pump:** A membrane protein that uses metabolic energy to create ion concentration gradients across neuronal membranes.

**Ischemia:** A paucity or complete lack of blood supply; a common cause of stroke.

**Laterality:** A term describing the relative specializations of the left and right sides of the brain.

**Localization:** The theory that specific areas of the brain are responsible for specific functions.

**Myelin:** Insulation around axons that increases the speed and fidelity of electrical conduction.

**Nerve:** A collection of peripheral axons that are bundled together and travel a common route.

**Nervous system:** The network of nerve cells throughout the body.

**Neural circuit:** A collection of interconnected neurons mediating a specific function.

**Neural correlate:** A measure of brain function that covaries with the expression of a cognitive function.

**Neural network:** An ensemble of neurons that can extend throughout the brain, working together to perform one or more functions.

**Neurology:** A clinical field that studies and treats brain-related illnesses which very often have psychiatric consequences.
**Neuron (or nerve cell):** A cell specialized for the conduction and transmission of electrical signals in the nervous system via electrical and chemical impulses.

**Neuroplasticity:** The many ways in which neurons change in order to hold information to support new learning.

**Neuropsychiatry:** A clinical field that focuses on the interface between neurological compromises and their behavioural consequences.

**Neuropsychology:** A clinical field that focuses primarily on the assessment and rehabilitation of brain-related disabilities.

**Neuroscience:** The vast area of study of the anatomy and functioning of the brain and nervous system.

**Neurotransmitter:** The chemical messenger that passes from one neuron to another.

**Neurotransmitter receptor:** A molecule embedded in the membrane of a postsynaptic cell that binds a neurotransmitter.

**Neurotrophin:** Growth factor that serves to enhance the development, functioning, and survival of neurons.

**Nociceptor:** A cell that responds specifically to potentially harmful stimuli.

**Norepinephrine (adrenaline):** A hormone with the primary function of activating and mobilizing the body for the fight-flight response.

**Nucleus:** The part of the neuron with the soma that contains DNA, mitochondria, and other structures central to neuronal functioning.

**Oxytocin:** A hormone that plays a key role in bonding, attachment, reproduction, and childbirth—called the love hormone.

**Parasympathetic nervous system:** A branch of the ANS that down-modulates arousal and supports bodily maintenance.

**Plasticity:** Malleability; the quality of dynamically changing in response to environmental and developmental factors or in response to damage.

**Psychopharmacology:** The field focused on the development and use of medications to treat psychological illnesses.

**Receptive field:** The region of the receptor surface of a sensory neuron that, when stimulated, elicits a response in the neuron being examined.
Reflex arc: A reaction of the nervous system that takes place at the level of the spinal cord and does not involve the brain. An example is pulling your hand away from a hot stove or reflexively braking a car in an emergency.

Sensory adaptation: The adjustment of sensory receptors or other elements in a sensory system to different levels of stimulus intensity; allows sensory systems to operate over a wide range of stimulus intensities.

Sensory system: All the components of the central and peripheral nervous systems concerned with processing information arising from a particular stimulus category (e.g., light, sound stimuli).

Serotonin: A neurotransmitter involved in cognition, learning, memory, and feelings of well-being.

Soma: The cell body of a neuron that contains the nucleus.

Somatotopic: refers to a representation of the body mapped on to the cortex of the brain in a topographically preserved way, meaning that adjacent locations on the surface of the body have adjacent representations in the cortex, even if perhaps stretched or distorted. The primary motor cortex and the somatosensory area of the brain are two somatotopically organized areas.

Sympathetic nervous system: A branch of the ANS that regulates processes of activation and the fight-flight-freeze response.

Synapse: A specialized point of contact between the axon of a neuron (the presynaptic cell) and a target (postsynaptic) cell. Information is transferred between the presynaptic and postsynaptic cells by the release and receipt of biochemical neurotransmitters.

Threshold potential: The membrane potential at which a nerve cell fires an action potential.

Tract: A major white matter (axonal) pathway in the brain.

4.1.2 Neuronal regions

Allocortex: The more primitive three-layer structure of the cingulate and insular cortices.

Amygdala: A nuclear complex in the temporal lobe that forms part of the limbic system; its major functions concern autonomic, emotional, and sexual behaviour.
**Anterior cingulate cortex:** The portion of the midline frontal lobe comprising the anterior extent of the cingulate gyrus and adjacent cortex; its dorsal regions are associated with executive functions.

**Anterior commissure:** A small midline fiber tract that lies at the anterior end of the corpus callosum; like the callosum, it serves to connect the two hemispheres.

**Association Areas:** The area within the cortex where sensory and motor information is combined and associated with stored knowledge. Responsible for most of the things that make humans seem human and are involved in higher mental functions, such as learning, thinking, planning, judging, moral reflecting, figuring, and spatial reasoning.

**Association cortex:** Defined by exclusion as those neocortical regions that are not involved in primary sensory or motor processing.

**Basal forebrain nuclei:** A complex of primarily cholinergic nuclei that lies between the hypothalamus in the diencephalon and the orbital cortex of the frontal lobes; concerned with alertness and memory, among other functions.

**Basal ganglia:** A group of nuclei lying deep in the subcortical white matter of the frontal lobes that organize motor behaviour. The caudate, putamen, and globus pallidus are the major components of the basal ganglia; the subthalamic nucleus and substantia nigra are often included.

**Brainstem:** The portion of the brain that lies between the diencephalon and the spinal cord; comprises the midbrain, pons, and medulla.

**Broca's area:** An area in the left frontal lobe specialized for the production of speech.

**Caudate (caudate nucleus):** One of the three major components of the basal ganglia (the other two are the globus pallidus and putamen).

**Central sulcus:** A major sulcus on the lateral aspect of the cerebral hemispheres that forms the boundary between the frontal and parietal lobes. The anterior bank of the sulcus contains the primary motor cortex; the posterior bank contains the primary sensory cortex.

**Cerebellum:** Prominent hindbrain structure concerned with motor coordination, posture, and balance. Composed of a three-layered cortex and deep nuclei; attached to the brainstem by the cerebellar peduncles (see preceding entry).

**Cerebral cortex:** The superficial gray matter of the cerebral hemispheres.

**Cerebral hemispheres:** Either of the two symmetrical halves of the cerebrum.
Cerebral peduncles: The numerous major axon tracts that connect the brainstem to the cerebral hemispheres. They include the important corticospinal and corticobulbar tracts.

Cerebrum: The largest and most rostral part of the brain in humans and other mammals, consisting of the two cerebral hemispheres.

Cingulate cortex: Cortex of the cingulate gyrus that surrounds the corpus callosum; important in emotional and visceral motor behaviour.

Cingulate gyrus: Prominent gyrus on the medial aspect of the hemisphere, lying just superior to the corpus callosum; forms a part of the limbic system.

Corpus callosum: The large midline fiber bundle that connects the cortices of the two cerebral hemispheres.

Cortex: The superficial mantle of gray matter (a sheet-like array of nerve cells) covering the cerebral hemispheres and cerebellum, where most of the neurons in the brain are located.

Corticospinal tract: Pathway carrying motor information from the primary and secondary motor cortices to the spinal cord in humans. Essential for the performance of discrete voluntary movements, especially of the hands and feet.

Cytoarchitectonic areas: Distinct regions of the neocortical mantle identified by differences in cell size, packing density, and laminar arrangement (layering). Most prominent in humans is the 6-layered neocortex. The evolutionary older archicortex (or hippocampal cortex) has 3–4 layers, and the ancient paleocortex has 3 layers.

Default-mode network: A network of the brain that includes the posterior cingulate cortex, the ventral anterior cingulate cortex, and the medial inferior prefrontal cortex and that has been proposed to be engaged when the brain is either “idling,” not engaged in any specific cognitive task, or directing attention inwardly.

Diencephalon: Portion of the brain that lies just rostral to the midbrain; comprises the thalamus and hypothalamus. The diencephalon and telencephalon compose the prosencephalon.

Dorsal columns: Major ascending tracts in the spinal cord that carry mechanosensory information from the first-order sensory neurons in dorsal root ganglia to the dorsal column nuclei; also called the posterior funiculi.

Dorsal horn: The dorsal portion of the spinal cord gray matter, which contains neurons that process sensory information.
**Dorsolateral prefrontal cortex:** A functional division of the prefrontal cortex roughly corresponding to the middle and superior frontal gyri, as located anterior to motor cortex and the frontal eye fields. Compare ventrolateral prefrontal cortex.

**Dorsomedial prefrontal cortex:** A functional division of the prefrontal cortex roughly corresponding to the medial surface dorsal to the corpus callosum. Compare ventromedial prefrontal cortex.

**Forebrain:** The anterior portion of the brain that includes the cerebral hemispheres (the telencephalon and diencephalon).

**Frontal eye field:** A region of the frontal lobe that lies in a rostral portion of the premotor cortex and that contains cells that respond to visual and motor stimuli.

**Frontal lobe:** One of the four lobes of the brain; includes all the cortex that lies anterior to the central sulcus and superior to the lateral fissure.

**Fusiform face area (FFA):** A region of the fusiform gyrus that shows enhanced responses to faces relative to other objects.

**Globus pallidus:** One of the three major nuclei that make up the basal ganglia in the cerebral hemispheres; relays information from the caudate and putamen to the thalamus.

**Gray matter:** Regions of the central nervous system that are rich in neuronal cell bodies; includes the cerebral and cerebellar cortices, the nuclei of the brain, and the central portion of the spinal cord.

**Grid Cells:** located in the entorhinal cortex, grid cells have firing fields dispersed across the environment in a hexagonal grid and are thought to help code an animal's location within a wider environmental context.

**Gyrus (pl. gyri):** The ridges of the infolded cerebral cortex (the valleys between these ridges are called sulci).

**Hippocampus:** A cortical structure in the medial portion of the temporal lobe; in humans, concerned with short-term declarative memory, among many other functions.

**Hypothalamus:** A collection of small but critical nuclei in the diencephalon that lies just inferior to the thalamus; governs reproductive, homeostatic, and circadian functions.

**Insula:** The portion of the cerebral cortex that is buried within the depths of the lateral fissure. Also called insular cortex.

**Lateral columns:** The lateral regions of spinal cord white matter that convey motor information from the brain to the spinal cord.
Lateral (Sylvian) fissure: The cleft on the lateral surface of the brain that separates the temporal and frontal lobes.

Lateral horn: The lateral portion of the spinal cord gray matter, which mediates sympathetic motor responses.

Limbic lobe: Cortex that lies superior to the corpus callosum on the medial aspect of the cerebral hemispheres; forms the cortical component of the limbic system.

Limbic system: Term that refers to those cortical and subcortical structures concerned with the emotions; the most prominent components are the cingulate gyrus, the hippocampus, and the amygdala.

Lobes: The four major divisions of the cerebral hemispheres (frontal, parietal, occipital, and temporal).

Locus coeruleus: A small brainstem nucleus with widespread adrenergic cortical and descending connections; important in the governance of sleep and waking.

Lower motor neuron: Spinal motor neuron; directly innervates muscle (also referred to as α or primary motor neuron).

Medulla: The caudal portion of the brainstem, extending from the pons to the spinal cord.

Meninges: The external covering of the brain; includes the pia, arachnoid, and dura mater.

Midbrain (or mesencephalon): The most rostral of the three components of the brainstem; identified by the superior and inferior colliculi on its dorsal surface, and the cerebral peduncles on its ventral aspect.

Motor cortex: The region of the cerebral cortex lying anterior to the central sulcus and concerned with motor behaviour. Includes the primary motor cortex in the precentral gyrus and associated cortical areas in the frontal lobe.

Neocortex: The six-layer structure of the frontal, temporal, parietal, and occipital lobes.

Nucleus accumbens: A subdivision of the ventral striatum that contains neurons sensitive to the neurotransmitter dopamine and contributes to learning and reward evaluation.

Occipital lobe: The posterior lobe of the cerebral hemisphere; primarily devoted to vision.
**Orbitofrontal (or Orbital prefrontal) cortex:** Divisions of the prefrontal cortex that lie above the orbits in the most rostral and ventral extension of the sagittal fissure. Important in emotional processing and rational decision-making.

**Papez’s circuit:** System of interconnected brain structures (mainly cingulate gyrus, hippocampus, and hypothalamus) in the medial aspect of the telencephalon and diencephalon described by James Papez. Participates in emotional processing, short-term declarative memory, and autonomic functions.

**Parietal lobe:** The lobe of the brain that lies between the frontal lobe anteriorly, and the occipital lobe posteriorly.

**Peripheral nervous system:** The nervous system beyond the brain and spinal cord that extends throughout the body.

**Pons:** One of the three components of the brainstem, lying between the midbrain rostrally and the medulla caudally.

**Prefrontal cortex:** Cortical regions in the frontal lobe that are anterior to the primary and association motor cortices; thought to be involved in planning complex cognitive behaviours and in the expression of personality and appropriate social behaviour.

**Premotor cortex:** Motor association areas in the frontal lobe anterior to the primary motor cortex; thought to be involved in planning or programming of voluntary movements.

**Primary auditory cortex (A1):** The major cortical target of the neurons in the medial geniculate nucleus.

**Primary motor cortex:** A major source of descending projections to motor neurons in the spinal cord and cranial nerve nuclei; located in the precentral gyrus (Brodmann’s area 4) and essential for the voluntary control of movement.

**Primary somatosensory cortex (S1):** The cortex of the postcentral gyrus of the parietal lobe that receives mechanosensory input from the thalamus.

**Primary visual cortex (V1):** Brodmann’s area 17 in the occipital lobe; major cortical target of the retinal sensory cells. Also called striate cortex because the prominence of layer 4 in myelin-stained sections gives this region a striped (striated) appearance.

**Putamen:** One of the three major nuclei that make up the basal ganglia (the other two are the caudate and the globus pallidus).
**Pyramidal tract**: White matter tract that lies on the ventral surface of the medulla and contains axons descending from motor cortex to the spinal cord.

**Pyriform cortex**: Component of cerebral cortex in the temporal lobe pertinent to olfaction; so named because of its pearlike shape.

**Raphe nuclei**: Brainstem nuclei involved in the control of the sleep-wake cycle, among other functions related to arousal.

**Reticular activating system**: A set of nuclei throughout the brain stem that regulates consciousness and arousal.

**Reticular formation**: A network of neurons and axons that occupies the core of the brainstem, giving it a reticulated ("net-like") appearance in myelin-stained material; major functions include control of respiration and heart rate, posture, and state of consciousness.

**Rhombencephalon**: The part of the brain that includes the pons, cerebellum, and medulla (derived from the embryonic hindbrain vesicle).

**Somatosensory cortex**: The region of the cerebral cortex concerned with processing sensory information from the body surface, subcutaneous tissues, muscles, and joints. Located primarily in the posterior bank of the central sulcus and on the postcentral gyrus.

**Spinal cord**: The portion of the central nervous system that extends from the lower end of the brainstem (the medulla) to the cauda equina.

**Spinothalamic tract**: Ascending white matter tract carrying information about pain and temperature from the spinal cord to the VP nuclear complex in the thalamus; also referred to as the anterolateral tract.

**Striatum**: The input nuclei of the basal ganglia, consisting of the caudate and the putamen. So called because of the striped appearance of these structures in brain sections.

**Substantia nigra**: Basal ganglionic nucleus at the base of the midbrain that receives input from several cortical and subcortical structures. The cells of the substantia nigra pars compacta send their output to the caudate/putamen, while the cells of the substantia nigra pars reticulata send their output to the thalamus.

**Sulcus (pl. sulci)**: Infoldings of the cerebral hemisphere that form the valleys between the gyral ridges.
Supplementary motor cortex: Also called supplementary motor area or area 6. A premotor area, lying anterior to the primary motor cortex on the medial surface of the cerebral hemisphere, that plays an important role in movement planning.

Telencephalon: The part of the brain derived from the anterior part of the embryonic forebrain vesicle; includes the cerebral hemispheres (cerebrum).

Temporal lobe: The hemispheric lobe that lies inferior to the lateral fissure.

Thalamus: A collection of nuclei that forms the major component of the diencephalon. Although its functions are many, a primary role of the thalamus is to relay sensory information from lower centres to the cerebral cortex.

Upper motor neuron: A neuron that gives rise to a descending projection that controls the activity of lower motor neurons in the brainstem and spinal cord.

Ventral horn: The ventral portion of the spinal cord gray matter, which contains the primary motor neurons.

Ventral striatum: The portion of the ventral caudate and putamen that encompasses the nucleus accumbens.

Ventral tegmental area (VTA): A part of the midbrain that contains many dopaminergic neurons and is important for reward and learning.

Ventricles: The fluid-filled spaces in the vertebrate brain that represent the lumen of the embryonic neural tube.

Ventromedial prefrontal cortex: The ventral portion of the prefrontal cortex surrounding the hemispheric midline; plays a key role in the control of emotions and social behaviour.

Wernicke’s area: Region of cortex in the superior and posterior region of the left temporal lobe that helps mediate language comprehension. Named after the nineteenth-century neurologist Carl Wernicke.

White matter: A general term that refers to large axon tracts in the brain and spinal cord; the phrase derives from the fact that axonal tracts have a whitish cast when viewed in the freshly cut material.
4.2 Cognition

**Absolute threshold of a sensation:** The intensity of a stimulus that allows an organism to just barely detect it.

**Abulia:** A symptom of brain damage, often to the frontal lobes, that manifests as flat affect, limited willpower, and reduced motivation.

**Acquisition:** In conditioning, the gradual learning of a conditioned response.

**Actor-critic learning model:** A framework for learning that posits two independent elements: a critic that learns rules mapping actions to rewards, and an actor that learns the optimal policy for selecting actions.

**Acuity** The ability of a sensory system to accurately discriminate spatial detail; usually tested by the ability to spatially discriminate two points, as in the Snellen eye chart exam for vision. Applies to all the sensory systems, but most obviously to vision and somatic sensation.

**Anchoring heuristic:** A bias in decision making in which judgments are influenced by a number that serves as a reference point, or anchor, for further deliberations.

**Anosognosia:** Lack of awareness of one’s own disability.

**Anterograde amnesia:** The inability to lay down new memories.

**Apparent motion:** The sensation of motion elicited by presentation of a stimulus in two successive positions over a brief interval.

**Attention:** The marshalling of cognitive processing resources on a particular aspect of the external or internal environment, or on internal processes such as thoughts or memories. A state of focused awareness on a subset of the available perceptual information.

**Attentional blink:** A cognitive phenomenon, typically observed in a rapidly presented stream of stimuli, in which the ability to successfully report a second target stimulus occurring within 150 to 450 milliseconds of a successfully reported first target in the stream is decreased.

**Attentional stream paradigm:** A paradigm used in attention research in which two or more segregated series of stimuli are presented in parallel and subjects selectively attend to one of the series to perform a task.

**Attitudes:** Opinions, feelings, and beliefs about a person, concept, or group. Our evaluations of things that can bias us toward having a particular response to it.
Autobiographic memory: Memory of one’s personal experience.

Automatic cognition: Thinking that occurs out of our awareness, quickly, and without taking much effort.

Availability heuristic: The tendency to make judgments of the frequency or likelihood that an event occurs on the basis of the ease with which it can be retrieved from memory.

Awareness: A cognitive/perceptual state in which an individual both shows knowledge of an event or stimulus and can report the subjective experience of having that knowledge.

Behavioural economics: A new social science discipline that combines elements of traditional economics and psychology to explain real-world decisions, including observed biases in choice.

Behaviourism: A perspective in cognitive psychology that holds that only directly observable behaviour, and not internal mental states, can be studied scientifically.

Beta effect: The perception of motion that occurs when different images are presented next to each other in succession.

Bias (i.e., test bias): A test that predicts outcomes better for one group than it does for another.

Biased competition: A theory of attention that proposes that related parallel processing routes for emotional expression and emotional experience. Stimulus inputs compete in a mutually inhibitory fashion for neural processing priority and that a key role of attention is to bias the processing towards those items that are attended.

Binding problem: The neural and cognitive processing problem by which the multiple features of an object (e.g., its colour, shape, orientation) are integrated together to yield a single perceptual object. Tends to be called a “problem” because it is still mostly unclear how this is accomplished in the brain.

Biological rhythms: Regularly occurring cycles of behaviours.

Blatant biases: Conscious beliefs, feelings, and behaviour that people are perfectly willing to admit, which mostly express hostility toward other groups while unduly favouring one’s own group.

Bottom-Up Attentional Selection: Attention-directing schema in which some intrinsic aspect of the stimulus itself causes it to be attended or to receive priority in processing.
**Bottom-Up Processing:** information processing in which incoming stimulus data initiate and determine the higher-level processes involved in their recognition, interpretation, and categorization; Typically, perceptual or cognitive mechanisms use bottom-up processing when information is unfamiliar or highly complex.

**Bounded rationality:** The idea that biological limitations on cognitive processing prevent people from making decisions or from reasoning in a fully rational manner.

**Cerebral achromatopsia:** Loss of colour vision as a result of damage to the visual cortex.

**Chunking:** The process of organizing information into smaller groupings (chunks), thereby increasing the number of items that can be held in short term memory.

**Classical conditioning:** The procedure in which an initially neutral stimulus (the conditioned stimulus, or CS) is paired with an unconditioned stimulus (or US). The result is that the conditioned stimulus begins to elicit a conditioned response (CR). Classical conditioning is nowadays considered important as both a behavioural phenomenon and as a method to study simple associative learning. Same as Pavlovian conditioning. Describes stimulus-stimulus associative learning.

**Cocktail party effect:** An attentional phenomenon in which an individual can selectively focus attention on one particular speaker while tuning out other simultaneously occurring conversations.

**Cognition:** “Higher-order” mental processes.

**Cognitive accessibility:** The extent to which knowledge is activated in memory, and thus likely to be used in cognition and behaviour.

**Cognitive control:** Process of guiding or controlling one’s thoughts and actions.

**Cognitive functions:** The set of processes that allow humans and many other animals to perceive external stimuli, to extract key information and hold it in memory, and ultimately to generate thoughts and actions that help reach desired goals.

**Cognitive map theory:** A theory positing that the hippocampus mediates memory for spatial relations among objects in the environment.

**Cognitive model:** A explanatory framework that invokes unobserved internal states to predict how stimuli lead to actions.

**Cognitive neuroscience:** A scientific discipline that seeks to create models that explain the interrelations between brain function and cognitive functions.
Cognitive psychology: A field of psychology that studies mental processes, including perception, thinking, memory, and judgement.

Cognitive resources: Cognitive resources are defined by the amount of activation of the nervous system that is potentially available to an individual for information storage and processing.

Cognitive science: A scientific discipline that seeks to understand and model the information processing associated with cognitive functions.

Concept: The mental representation of a category. It is also what we use to think about things. Thinking about emotions requires having a concept of emotion.

Conceptual priming: A form of direct priming in which the test cue and the target are semantically related.

Conditioned response (CR): In classical conditioning, the reflex (normally innate in response to a particular unconditioned stimulus) that is triggered by a novel stimulus by virtue of repeated association.

Conditioned stimulus (CS): in associative learning, a stimulus that has acquired the ability to cause a response through association with another stimulus (the unconditioned stimulus, US).

Conditioning: The generation of a novel response that is gradually elicited by repeated pairing of a novel stimulus (the conditioned stimulus) with a stimulus that normally elicits the response being studied (the unconditioned stimulus).

Confabulation: In patients with memory disorders, the generation of false memories for complex autobiographical events.

Confirmation Bias: The tendency to verify and confirm our existing memories rather than to challenge and disconfirm them. A result of our schemas influencing how we seek out and interpret new information. Confirmation bias influences memory in such a way that information that fits our schemas is better remembered than information that disconfirms our schemas.

Conformity: A process in which people change their beliefs and behaviours to be similar to those of the people that they care about.

Connectionist: Pertaining to the connectivity of neural networks whose connection weights vary according to experience.
**Consciousness:** An intriguing but puzzling concept that includes the ideas of wakefulness, awareness of the world, and awareness of the self as an actor in the world.

**Consolidation:** The strengthening of memory traces following encoding.

**Construct validity:** the adequacy with which a dependent measure (e.g., task performance) can be used to infer a latent variable (e.g., a central emotion state).

**Context-Dependent Learning:** An increase in retrieval when the external situation in which information is learned matches the situation in which it is remembered.

**Covert attention:** The focusing of visual attention toward a location or item in the visual field without shifting the direction of gaze. Can apply to other sensory modalities or to attentional paradigms.

**Cues:** A stimulus that has a particular significance to the perceiver (e.g., a sight or a sound that has special relevance to the person who saw or heard it).

**Declarative memory:** Also called explicit memory. Memory available to consciousness that can be expressed by language.

**Default mode:** Brain processes that occur in the absence of active executive control; a pattern of brain activation reflecting a set of cognitive processes that are typically more engaged during passive experience.

**Delay conditioning:** A form of classical conditioning in which the conditioned stimulus is still ongoing when the unconditioned stimulus starts, and they both terminate at the same time.

**Delay-period activity:** In cognitive neuroscience studies of working memory, the observation of neural signals that persist while the research subject maintains information over time.

**Depth perception:** The ability to perceive three-dimensional space and to accurately judge distance. In vision the perception of distance from the observer.

**Difference Threshold (or Just Noticeable Difference [JND]):** The change in a stimulus that can just barely be detected by the organism.

**Direct priming:** Also called repetition priming. The facilitation of recall in which the prime and the target are identical or have the same name.

**Dopamine system:** Refers to the circuits in the brain that include neurons that release the neurotransmitter dopamine. The dopaminergic neurons, which are mostly located in
the ventral tegmental area of the midbrain, the substantia nigra pars compacta, and the hypothalamus, have been particularly associated with reward.

**Double dissociation:** A functional relationship in which one area of the brain is experimentally shown to be associated with a particular task or cognitive function and not with another task or function, whereas another area is shown to be involved in the second task or function but not the first. This demonstration thus distinguishes the cognitive roles of different regions in a more rigorous way than does simply showing that the two regions in question respond differently.

**Drift-diffusion model:** A mathematical description of decision-making behaviour in terms of competing processes that drift in a random-walk fashion toward boundaries.

**Early selection:** A model of attention postulating that attentional mechanisms can selectively filter out or attenuate irrelevant sensory input at an early processing stage, before the completion of sensory and perceptual analysis.

**Embodied:** Becoming so closely in touch with the environment that the person’s body and the sensed environment becomes linked with our cognition, such that the world around us becomes part of our brain. A sense of physical location of the self within one’s own body.

**Encoding:** The incorporation of new information into a memory store, which requires the modification or creation of memory traces.

**Endowment effect:** A bias in decision making in which people will pay less to buy something than they would accept to sell the same thing, if they already possessed it.

**Episodic memory:** Declarative memory that refers to memory for personally experienced past events. As a theory it proposes that the hippocampus is critical for episodic memory but not for semantic memory.

**Executive function:** The ability to hold in mind information in working memory, to inhibit fast and unthinking responses to stimulation, and to flexibly shift the focus of one’s mental frame. Also viewed as the cognitive functions that allow flexible and goal-directed control of thought and behaviour.

**Expected utility:** The personal value (i.e., utility) placed on the potential outcome of a decision, as derived from the combination of the value and probability of its potential outcomes. Compare expected value.
Expected value: The average value in a particular currency (e.g., dollars) of the potential outcome of a decision as weighted by the relative probabilities of those outcomes. Compare expected utility.

Experience-dependent systems: Neural systems that vary across people and are based on the individuals' personal, unique experiences.

Experience-expectant systems: Neural systems that respond to experiences universally present in normal development, relying upon external information essential for development but not specified in genetic blueprint.

Feature integration theory: A model of attention postulating that the visual perceptual system is organized as a set of feature maps, each providing information about the location(s) in the visual field of a particular feature. The model also proposes that attention is required to integrate the feature information from these separate maps into a perceptual whole.

Fictive learning: The adjustment of rules for behaviour based on reward outcomes that were observed, but not received directly.

Frames of reference: Concept that we can understand the spatial location of an object with respect to multiple reference points.

Framing effect: A mode of representing a decision-making scenario that changes the decisions people make, even though the basic structure of the problem is left unchanged.

Generalization: The extent to which relationships among conceptual variables can be demonstrated in a wide variety of people and a wide variety of manipulated or measured variables. It is also viewed as a property of emotions describing how many stimuli can cause one emotion, which in turn can cause many behaviours (“Fan-in, fan-out” architecture).

Guided search: A cognitive model positing that there are two basic components that determine the allocation of attention during visual search: a component driven by stimulus (bottom-up) information and one driven by top-down influences based on high-level factors and behavioural goals.

Habit: Instrumental behaviour that occurs automatically in the presence of a stimulus and is no longer influenced by the animal’s knowledge of the value of the reinforcer. Insensitive to the reinforcer devaluation effect.
**Habitation:** The process by which a behavioural response to the same stimulus decreases in intensity, frequency, or duration when that stimulus is repeated over and over.

**Hebbian learning:** The idea, proposed by Donald Hebb in the late 1940s, that when presynaptic and postsynaptic neurons fire action potentials together, the strength of the synaptic connections between them is enhanced. Hebb’s rule is often state as “cells that fire together wire together.”

**Hemispatial neglect:** A deficit in the ability to attend to the left side of space, and often to the left side of objects, typically caused by damage to the right parietal lobe. Occasionally damage to the left parietal lobe can cause corresponding deficits for attending to the right side of space, but much more rarely.

**Heuristic(s):** Cognitive (or thinking) strategies that simplify decision making by reducing complex problem-solving to simpler, rule-based decisions. These information processing strategies are useful in many cases but may lead to errors when misapplied. Two frequently applied heuristics include the representativeness heuristic and the availability heuristic.

**Higher-order thinking:** Set of abilities involving complicated aspects of thoughts, such as being able to think in an abstract and conceptual rather than concrete manner, the ability to deduce rules of regularity, and the ability to be flexible and respond to novelty.

**Hindsight bias:** Refers to the tendency to think that we could have predicted something that has already occurred that we probably would not have been able to predict.

**Illusory conjunction:** A perceptual process in which sensory features from different objects in a scene are falsely perceived as being part of the same object.

**Inattentional Blindness:** The failure to notice a fully visible object when attention is devoted to something else.

**Indirect priming:** The facilitation of recall by an item (the prime) that is not directly related to that item. For example, the word winter may indirectly prime both summer and snow.

**Inference:** The ability to “fill in the blanks” and make assumptions about material that is not explicitly stated (implied material).

**Innate:** Determined to develop from birth. Also termed instinctive, and distinct from genetic, acquired, and congenital. The capacity for language is innate in humans, even
though it involves both genetic and acquired factors and is not congenital but emerges over development.

**Instructive:** in distinction to permissive, a causal factor that carries information. In making your car drive, how hard you press the gas pedal is instructive, whereas having any gas in your tank is permissive.

**Joint attention:** The sharing of a common focus of attention across at least two individuals.

**Late selection:** A theory of attention postulating that all stimuli are processed through the completion of sensory and perceptual analysis before any selection or influence of attention occurs.

**Learning:** The combined effect of all encoding, storage, and retrieval in gradually enhancing the performance of a particular task.

**Levels of processing:** Declarative memory encoding is usually better when information is processed at a semantic (deep) level rather than at a perceptual (shallow) level.

**Limited Capacity:** The notion that humans have limited mental resources that can be used at a given time.

**Loudness:** The sensory quality elicited by the intensity of sound stimuli.

**Luminance:** The physical measure of light intensity.

**Memory:** Processes by which information is encoded (learned), stored, and retrieved.

**Memory search:** A process during memory retrieval that explores possible locations of a target memory.

**Metacognition:** Cognition about cognition, usually referring to “higher-order” control and awareness of cognitive processes. Describes the knowledge and skills people have in monitoring and controlling their own learning and memory. The clearest example of a metacognitive ability is the ability to provide confidence judgments about one’s own task performances.

**Modality-specific attention:** The focusing attention on the stimulus information specifically within one sensory modality.

**Monitoring:** The process that evaluates the appropriateness of a given behaviour for the current context; examples include evaluating the accuracy of answers generated during a memory test or the adequacy of a response rule in an executive function paradigm.
Motivation: An internal state, related to (but distinct from) emotion, which drives an animal to engage in a goal-directed behaviour. Motivational states can be triggered both by interoceptive stimuli (e.g., water or caloric deprivation) or exteroceptive stimuli (e.g., money).

Motor program: The plan to produce a particular motor action, such as writing one’s name, that occurs independently of the effectors used to carry out the movement.

Multisensory integration: The combining of sensory information from different sensory modalities, facilitating the linking of that information together into one perceptual object.

Nondeclarative memory: Also called implicit memory. Memory expressed through performance; assumed to operate unconsciously.

Operant conditioning: Also called instrumental learning. The altered probability of a behavioural response engendered by associating responses with rewards (or punishments).

Overt attention: The focusing of attention (typically visual) by voluntarily shifting gaze.

Perception: Term used to refer to how the brain organizes sensory information into meaningful representations of objects and scenes, such as visual objects or recognizable sounds.

Perceptual load: The level of processing difficulty or complexity of a task being performed by an individual; usually measured by the time it takes for perceptual analyses of the stimuli.

Perceptual priming: A form of direct priming in which the test cue and the target are perceptually related.

Perseveration: The repetition of a response despite changing stimuli or rules that make a different response more appropriate.

Primacy effect: A tendency to better remember stimuli that are presented early in a list.

Priming: Process by which exposing people to one stimulus makes certain thoughts, feelings, or behaviours more salient. The activation of certain thoughts or feelings that make them easier to think of and act upon.

Prospect theory: A quantitative decision-making model proposing that people make decisions in terms of the anticipated gains and losses from their current state, and that probabilities are subjective.
**Psychological construct:** A theoretical concept, often generated by converging results across experiments, that cannot be directly observed but serves to explain and unify a body of research.

**Punishment:** The delivery of an aversive stimulus.

**Recollection:** Remembering a past event, as well as specific associations and contextual details. Compare familiarity.

**Recovery:** During memory retrieval, the process of accessing stored memory traces.

**Repetition enhancement:** The creation of new representations and the increase in activity that result from the repetition of stimuli during priming; associated with priming for novel stimuli.

**Resting-state connectivity:** The patterns of functional connectivity of the brain while a person is awake but not engaged in any specific task or activity.

**Retrieval:** The recovery or accessing of stored memory traces.

**Retrieval cue:** Any information that leads to the retrieval of memories, such as the hits provided by memory tests.

**Retrograde amnesia:** The inability to recall memories for events that happened before the lesion or brain disorder that caused the memory loss.

**Reversal learning:** The capacities for recognizing that the rules mapping environmental events to behaviour have changed and for adjusting behaviour accordingly.

**Reward prediction error:** (RPE) A quantity given by the difference between the reward that was expected and what actually occurs; the activity of some dopaminergic neurons seems to convey this quantity.

**Reward value:** The likelihood that a particular movement will yield a reward, multiplied by the amount of reward expected.

**Risk aversion:** The tendency to prefer lower-risk options when making decisions, even in some situations when those options have reduced expected value.

**Schema:** (1) A mental model, or representation, of any of the various things we come across in our daily lives. (2) Also known as a memory template, created through repeated exposure to a particular class of objects or events. Patterns of knowledge in long-term memory that help people remember, organize, and respond to information.

**Secondary reinforcer:** A stimulus that has no direct effects on homeostatic processes but is nevertheless rewarding; money is a paradigmatic example.
Selective attention: Involves the choice of information essential to a task; often conceptualized as a filtering process that allows homing in on critical information from the vast amount of information available. This selection process can be performed on incoming sensory information, on information being kept “in mind”, or on the set of possible responses.

Selective forgetting: Letting go of certain ideas or concepts that may be inhibiting the problem-solving process.

Self-concept: A knowledge representation or schema that contains knowledge about us.

Self-construal: The way people define the way they “fit” in relation to others.

Semantic memory: Declarative memory that refers to general knowledge about the world, including knowledge of language, facts, and the properties of objects.

Semantic priming: A form of indirect priming in which the prime and the target are semantically related.

Sensation: A term usually used to describe the registration and initial encoding of sensory information, such as light and sound waves.

Sensitization: The process by which a behavioural response to an otherwise benign stimulus increases in intensity, frequency, or duration when that stimulus is paired with an aversive stimulus.

Sensory adaptation: The adjustment of sensory receptors or other elements in a sensory system to different levels of stimulus intensity; allows sensory systems to operate over a wide range of stimulus intensities.

Social cognition: The way we think about the social world and how we perceive others.

Social learning theory: The theory that people can learn new responses and behaviours by observing the behaviour of others. Argues that gender roles are learned through reinforcement, punishment, and modelling.

Source memory: The ability to recall or remember the specific circumstances or context in which particular information was learned.

Temporal difference learning: A form of learning that modulates behaviour according to the difference between an obtained reward and an estimate, compiled over the recent past, of an expected reward.
**Temporal discounting:** Also called delay discounting. The reduction in the desirability of an outcome based on the delay in time until it will be delivered.

**Theory of mind:** The human capacity to understand minds, a capacity that is made up of a collection of concepts (e.g., agent, intentionality) and processes (e.g., goal detection, imitation, empathy, perspective taking). The ability to take another person’s viewpoint.

**Top-down Processing:** Information processing in which an overall hypothesis about or general conceptualization of a stimulus is applied to and influences the analysis of incoming stimulus data; Typically, perceptual or cognitive mechanisms use top-down processing when information is familiar and not especially complex.

**Topographical mapping:** The specification of spatial relationships in the retina and in other stations of the primary visual pathway.

**Unconditioned response (UR):** In classical conditioning, the innate reflex that is naturally triggered by a particular stimulus.

**Unconditioned stimulus (US):** In classical conditioning, the stimulus that naturally triggers the innate reflex.

**Utility:** The personal worth associated with a good; may deviate from the stated value of that good depending on an individual’s preferences, biases, or current state.

**Ventral stream:** A partially segregated visual processing pathway passing from the primary visual cortex toward the temporal lobe that is especially pertinent to object recognition.

**Visual attention:** The brain’s ability to selectively filter unattended or unwanted information from reaching awareness.

**Visual search:** The searching in a visual scene with multiple stimulus items for a particular type of item possessing one or more specific feature attributes.

**Visual spatial attention:** Attention directed to a location in visual space.

**Volutility:** The degree to which the rules governing environmental events (e.g., the delivery of rewards) are changing or stable over time.

**Working Memory:** Memory held briefly in the mind that enables completion of a particular task (e.g., efficiently searching a room for a lost object).
4.3 Emotion

Affect: A general term for referring to either the pleasantness or unpleasantness of a sensation.

Affective forecasting: Predictions of one’s future feelings.

Affective neuroscience: The study of the neurobiological basis of emotions.

Affective perspective taking: Inferences drawn about the emotional state of another person based on the imagined perspective of the other and the perception of observable cues.

Affective state: Any mental state that can bear affect. This includes pains, pleasures, moods and emotion.

Aggression: A forceful action or procedure (such as an unprovoked attack) especially when intended to dominate or master.

Amazement: A feeling of astonishment; the quality or state of feeling or showing great surprise or wonder.

Anger: A strong feeling of displeasure and usually of antagonism.

Anhedonia: Reduced experience of positive affect; often accompanies depression.

Annoyed: Feeling or showing angry irritation.

Anticipation: (1) A prior action that takes into account or forestalls a later action; (2) the act of looking forward.

Appraisal (theory of emotion): A theory of emotion that states that emotional experiences are experiences of the situation as interpreted by the organism. Thus, the emotions people feel, along with their interpretation of the situation, is predictable from their appraisal of the situation. Appraisal can also be viewed as a feature of psychological emotion theories describing how emotions are induced through a complex series of evaluations.

Aprosodia: The inability to inflect speech with the usual emotional colour that the right hemisphere typically contributes to language. Characterized by a monotonic or “robotic” speech pattern.

Arousal: A state characterized by increased behavioural activity and sensitivity to sensory stimuli. Arousal states are graded and related to the emotion properties of intensity or scalability. There may be different types of arousal associated with different
emotion states. It can also be viewed as our experiences of the bodily responses created by the sympathetic division of the autonomic nervous system.

**Automaticity:** A property of emotions describing their priority over behavioural control, a common component of dual process models.

**Basic emotions:** Fundamental, first order emotions that are structurally and dynamically simpler (primarily due to a lack of cognitive influence) operating chiefly during early childhood (e.g., joy, fear). They develop earlier, constitute foundations for more complex or secondary emotions, emphasize survival, well-being, functional specificity and initiate fast, often automatic reactions. It can also be viewed as an emotion that is innate, pan-cultural, evolutionarily old, shared with other species, and expressed by a particular physiological pattern and facial configuration.

**Building blocks of emotion:** Properties of an emotion that are more essential, and more basic, also called “emotion primitives.” Simpler organisms show building blocks of emotion. Features (see below), on the other hand, are more elaborated, derived, and variable properties of emotions. To use an automotive analogy, wheels are a building block, while air conditioning is a feature.

**Cannon-Bard (theory of emotion):** A theory proposed by Walter Cannon and Philip Bard that states that the experience of an emotion is accompanied by physiological arousal.

**Catharsis:** (1) Purification or purgation of the emotions (such as pity and fear) primarily through art; (2) Elimination of a complex by bringing it to consciousness and affording it expression.

**Circumplex model:** A way to graphically represent the relationships among emotions by ordering them along the circumference of a circle formed by intersecting two orthogonal axes of valence and arousal at the circle’s centre.

**Cognitive bias:** A term used to describe an influence of emotion states on cognitive processes, such as decision-making. Cognitive bias can be negative (e.g., “pessimism”) or positive (e.g., “optimism”). Cognitive bias has been used to study emotion states in honeybees and several other animal species.

**Cognitive (re)appraisal:** A form of emotion regulation in which individuals use cognitive resources to alter the meaning of a situation in order to reduce or change its emotional impact. Also viewed as the cognitive interpretations that accompany emotions.
Confusion: The quality of state of being (1) perplexed or disconcerted; or (2) disoriented with regard to one's sense of time, place, or identity.

Complex emotion: An emotion that is learned, socially and culturally shaped, evolutionarily new, and typically expressed by a combination of the response patterns that characterize basic emotions.

Contempt: (1) The act of despising; (2) Lack of respect or reverence for something.

Contextual fear conditioning: A form of emotional learning in which fear responses are acquired in response to environments that predict the presence of an aversive stimulus.

Demand characteristics: behaviours evoked in a human subject experiment that are due to the external demands of the study, for instance the subjects knowing what the experimenter would like to see or hypothesizes. This is a major confound in human studies.

Despair: Utter loss of hope.

Disgust: Marked aversion aroused by something highly distasteful.

Domain specificity: Specialized processing for a particular domain of stimuli, like faces, language, or predators.

Doubt: To call into question the truth of.

Dual-system model: A framework for decision making that posits the existence of two independent systems—typically, a fast emotional system and a slower cognitive system—whose interactions over time predict choices.

Emarrass[ment]: To cause to experience a state of self-conscious distress.

Emotion: (1) A set of physiological responses, action tendencies, and subjective feelings that adaptively engage humans and other animals to react to events of biological and/or individual significance. (2) A mental and physiological feeling state that directs attention and guides behaviour; (3) A valent representation of a situated concern. The specific character of the emotion relies on the characteristics of the particular object, the formal features predicated of that object, and the characteristics of the response strategy.

Emotional contagion: The unintentional reproduction of an emotionally aroused state in (and unbeknownst to) an observer through the mimicking of the observed emotional responses.

Emotional intelligence (EI): The ability to monitor one’s own and others’ feelings and emotions, to discriminate among them, to use this information to guide one’s thinking.
and actions, and to effectively control one’s own emotions. EI includes four specific abilities: perceiving, using, understanding, and managing emotions.

**Emotion regulation:** The voluntary or involuntary deployment of resources to gain control over emotional responses. It is also viewed as a general term for attempts to manage the emotions that one experiences, so that they are socially appropriate and do not spiral out of control.

**Emotional perseveration:** The continuation of an emotional response to a stimulus after the emotional significance of the stimulus has changed and the response is no longer appropriate.

**Empathy:** The ability to understand another person’s feelings and can include (1) emotional contagion that causes us to feel as others feel; (2) cognitive perspective-taking that allows us to understand another person’s point of view; and (3) pro-social action, which involves behaviour targeted to help another person in need.

**Enjoy(ment):** To have a good time.

**Excite(ment):** (1) To call to activity; (2) to rouse to an emotional response (3) to arouse (something, such as a strong emotional response) by appropriate stimuli.

**Facial feedback hypothesis:** Proposes that the movement of our facial muscles can trigger corresponding emotions.

**Familiarity:** The feeling of having experienced an event at some point in the past, even though no specific associations or contextual detail come to mind.

**Fear:** An unpleasant often strong emotion caused by anticipation or awareness of danger.

**Fear conditioning:** A form of emotional learning in which fear responses are acquired to cues that predict the occurrence of an aversive stimulus.

**Fear extinction:** A form of emotional learning in which fear responses are reduced by repeated presentation of a feared stimulus without any unpleasant consequences.

**Feelings:** Subjective, conscious experiences of emotions and other states.

**Fight-or-flight response:** A reflex that prepares the body to respond to danger in the environment; An emotional and behavioural reaction to stress that increases the readiness for action.

**Guilt:** A feeling of deserving blame for offenses.
Joy: The emotion evoked by well-being, success, or good fortune or by the prospect of possessing what one desires.

Hostile attribution bias (HAB): The tendency to interpret the intention of others as hostile when social context cues are ambiguous. People who exhibit the HAB think that ambiguous behaviour of others is hostile and often directed toward them, while those who do not exhibit the HAB interpret the behaviour in a non-hostile, non-threatening way.

Impact bias: The tendency for a person to overestimate the intensity of their future feelings.

Interoception: The perception of the internal state of the body, usually nonconsciously.

James-Lange theory of emotion: A theory proposed by William James and Carl Lange that states that arousal and emotion are not independent, but rather that emotion depends on the pattern of arousal.

Jealous[y]: hostile toward a rival or one believed to enjoy an advantage.

Love: (1) strong affection for another arising out of kinship or personal ties; (2) warm attachment, enthusiasm, or devotion.

Misattribution of affect: The tendency for individuals to have difficulty disentangling their affective responses to two events occurring in close proximity in time and space.

Mood: Three types of mood are distinguished: (1) an ordinary emotional state in which the individual is not consciously aware of its object, but only the accompanying bodily feeling; (2) a bodily feeling that lingers after the repeated stimulation of an emotion and (3) an emotional bodily feeling stimulated prior to the emotional response to a particular object.

Mood regulation: The long-term balance between emotional and attentional processing. When these processes become skewed, mood disorders such as depression can occur.

Pride: The quality or state of being proud: such as (1) inordinate self-esteem, (2) a reasonable or justifiable self-respect, (3) delight or elation arising from some act, possession, or relationship.

Regulation of emotion: The ability to control your emotions.

Sadness: Affected with or expressive of grief or unhappiness.

Safe: Secure from threat of danger, harm, or loss.
**Saliency map**: A theoretical construct of visual attention in which the importance of different stimuli in the visual field is set by a combination of top-down processes based on behavioural goals and bottom-up processes resulting from how distinctive the different elements of a stimulus are compared to the background.

**Satisfaction** - the quality or state of being satisfied.

**Sentiment** - an attitude, thought, or judgment prompted by feeling.

**Scalability**: A property of emotion states describing their magnitude or intensity.

**Social neuroscience**: The study of the neural basis of interpersonal and intergroup processes.

**Social referencing**: The use of emotions expressed by another individual to guide one’s own behaviour.

**Surprise**: The feeling caused by something unexpected or unusual.

**Sympathy**: Having feelings of pity or concern for another individual's plight without experiencing the same feelings expressed by that individual.

**Temperament**: A disposition to react to emotional situations either positively or negatively.

**Tense**: (1) Feeling or showing nervous tension; (2) marked by strain or suspense.

**Trust**: Assured reliance on the character, ability, strength, or truth of someone or something.

**Two-factor theory of emotion**: Asserts that the experience of emotion is determined by the intensity of the arousal we are experiencing, but that the cognitive appraisal of the situation determines what the emotion will be.

**Valence**: A property of emotions describing the dimension of pleasantness/unpleasantness.

**Vertical integration model**: A model of emotion that integrates cortical, subcortical, and visceral processes.

**Wakefulness**: The state in which one is not asleep.

**Worry**: Mental distress or agitation resulting from concern usually for something impending or anticipated.

**Zeal**: Eagerness and ardent interest in pursuit of something.
4.4 Terms for Mental Health

**Addiction (Drug or Alcohol):** It is a treatable, chronic medical disease involving complex interactions among brain circuits, genetics, the environment, and an individual’s life experiences. People with addiction (referred to as an addict) repeated use psychoactive substance (or substances) or engage in behaviours that become compulsive (to take the preferred substance or substances) and often continue despite harmful consequences.

**Affective disorder:** Affective disorders are also known as mood disorders. They are marked by changes in affect (mood/emotion). The term may be used to describe depression, bipolar disorder and mania.

**Agoraphobia:** It is defined as a marked fear or anxiety about two (or more) of the following five situations: (1) using public transportation; (2) being in open spaces; (3) being in enclosed spaces (e.g., shops, theatres, cinemas); (4) standing in line or being in a crowd; (5) being outside the home alone. The situations are avoided (e.g., travel is restricted) or else are endured with almost always marked fear, distress or anxiety about having a panic attack or panic-like symptoms or require the presence of a companion. The fear or anxiety is persistent (typically lasting 6 months or more) as well as out of proportion to the actual danger posed by the agoraphobic situations (and to the sociocultural context).

**Alcohol and drug dependence:** A cluster of physiological, behavioural and cognitive phenomena in which the use of alcohol or drugs takes on a much higher priority for a given individual than other behaviours that once had greater value. The alcohol or drug withdrawal state refers to a group of symptoms that may occur upon cessation of alcohol or drug after its prolonged daily use.

**Alcohol Use and Alcohol Use Disorders:** Conditions resulting from different patterns of alcohol consumption include acute alcohol intoxication, harmful alcohol use, the alcohol dependence syndrome, and the alcohol withdrawal state. Acute intoxication is a transient condition following intake of alcohol resulting in disturbances of consciousness, cognition, perception, affect or behaviour. Harmful use of alcohol is a pattern of alcohol consumption that is causing damage to health. The damage may be physical (e.g., liver disease) or mental (e.g., episodes of depressive disorder). It is often associated with social consequences (e.g., family problems, or problems at work).

**Alzheimer’s Disease:** A clinical–biological entity (i.e., based on both clinical and biomarker findings) defined by the presence of a specific clinical phenotype (phenotype
positive) associated with in-vivo biomarker evidence of Alzheimer’s pathology (amyloid-positive and tau positive). Specific clinical phenotypes commonly associated with Alzheimer’s disease pathology (common Alzheimer’s disease phenotypes) are the amnestic syndrome of the hippocampal type (typical), the posterior cortical atrophy variant, and the logogenic variant primary progressive aphasia (other phenotypes exist but are rare). In people who have these common phenotypes, the presence of amyloid β (low CSF Aβ42, increased CSF Aβ40–Aβ42 ratio or high tracer retention in amyloid positron emission tomography scan) and tau (high CSF phosphorylated tau or increased ligand retention in tau positron emission tomography scan) biomarker positivity establishes an Alzheimer’s disease diagnosis. Importantly, the conclusion of diagnosis requires clinician expertise in the assessment of both clinical and biomarker results.

**Antidepressants:** Medicines aim to treat the symptoms of depression and can help people experiencing depression to feel more motivated and energetic. This group of medication may also be used to treat obsessive-compulsive disorder, anxiety and eating disorders. There are different types of antidepressants including tricyclic and selective serotonin reuptake inhibitors (SSRIs).

**Antipsychotic medication:** Medication normally given to treat the symptoms of schizophrenia and, in some cases, manic depression and manias. The two main types of antipsychotics are called typical and atypical (see definitions). The main difference between the two groups is in their side effects.

**Anxiety:** This is the term used to describe experiences of “excessive worry” (such as chronic fear, tension and panic attacks) and feelings of apprehension about everyday events/problems, with symptoms of muscle and psychic tension, causing significant distress/functional impairment. Sleepless nights and recurring thoughts are common, as well as nausea, palpitations, dizziness and difficulty in breathing. Anxiety is the most common mental health problem people experience.

**Anxiety disorders:** These are disorders that involve a continuous state of anxiety or fear, lasting at least a month, marked by constant apprehension, difficulties in concentration and a pounding heart. Physical symptoms may also be present, such as headaches, sweating, irritability, and nausea. Anxiety disorders include separation anxiety disorder, selective mutism, specific phobia, social phobia, panic disorder, agoraphobia, and generalized anxiety disorder. Depression is common in those with anxiety disorders.
**Cognitive testing**: In surveys, studying the process of interpretation of questions and the formation and reporting of responses by respondents to learn how to make the questions more accurately obtain the data the questionnaire is seeking.

**Delirium**: A disturbance in attention (i.e., reduced ability to direct, focus, sustain, and shift attention) and awareness (reduced orientation to the environment) that develops over a short period of time (usually hours to a few days). It represents a change from baseline attention and awareness, tends to fluctuate in severity during the course of a day, it is usually associated with an additional disturbance in cognition (e.g., memory deficit, disorientation, language, visuospatial ability, or perception) and it is not explained by another pre-existing, established, or evolving neurocognitive disorder and do not occur in the context of a severely reduced level of arousal, such as coma. Moreover, there is evidence from the history, physical examination, or laboratory findings that the disturbance is a direct physiological consequence of another medical condition, substance intoxication or withdrawal (i.e., due to a drug of abuse or to a medication), or exposure to a toxin, or is due to multiple etiologies.

**Delusions**: Are fixed false beliefs; they are based on incorrect (false) inferences about reality external to, or about, oneself and maintained firmly (fixed) despite the presentation of evidence that obviously and incontrovertibly contradicts the belief. They are often divided into ordinary (derive from misinterpretation of everyday experiences and, as such, are understandable but not accepted by other members of the person's culture or subculture) and bizarre (involve phenomena that are physically impossible or that most people in that person’s culture would regard as entirely implausible).

**Dementia**: A major cognitive disorder due to disease of the brain – usually of a chronic or progressive nature – in which there is a significant cognitive decline from a previous level of performance (not exclusively in the context of a delirium) in one or more cognitive domains (learning and memory; language; executive function; complex attention; perceptual-motor; or social cognition), not better explained by another mental disorder (e.g., major depressive disorder, schizophrenia) and that interfere with independence in everyday activities (at a minimum, assistance should be required with complex instrumental activities of daily living, such as paying bills or managing medications). Evidence of decline is based on concern of the individual, a knowledgeable informant, or the clinician that there has been a significant decline in cognitive function and a substantial impairment in cognitive performance, preferably documented by standardized neuropsychological testing or, in its absence, another quantified clinical assessment. The impairments of cognitive function are commonly accompanied, and
occasionally preceded, by deterioration in emotional control, social behaviour, or motivation. Alzheimer's disease is the most common form of dementia and possibly contributes to 60–70% of cases. Other major contributors include vascular dementia, dementia with Lewy bodies, and a group of diseases that contribute to frontotemporal dementia. The boundaries between subtypes are indistinct and mixed forms often co-exist.

**Depression**: Depression is a common mental disorder, characterized by five or more symptoms during the same 2-week period and at least one of the symptoms should be either (1) depressed mood most of the day, nearly every day or (2) markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day. The remaining potential symptoms include: (3) significant weight loss when not dieting or weight gain, or decrease or increase in appetite nearly every day; (4) slowing down of thought and a reduction of physical movement (observable by others, not merely subjective feelings of restlessness or being slowed down); (5) fatigue or loss of energy nearly every day; (6) feelings of worthlessness or excessive or inappropriate guilt nearly every day; (7) diminished ability to think or concentrate, or indecisiveness, nearly every day; (8) recurrent thoughts of death, recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide. Importantly, to receive a diagnosis of depression, these symptoms must cause the individual clinically significant distress or impairment in social, occupational, or other important areas of functioning (the symptoms must also not be a result of substance abuse or another medical condition).

**Diagnostic and Statistical Manual (DSM)**: This is a manual that classifies mental health problems and is used to diagnose people’s mental health problems. The American Psychiatric Association publishes it.

**Drug Use and Drug Use Disorders**: Conditions resulting from different patterns of drug use include acute sedative overdose, acute stimulant intoxication or overdose, harmful or hazardous drug use, cannabis dependence, opioid dependence, stimulant dependence, benzodiazepine dependence, and their corresponding withdrawal states. Harmful use of drugs is a pattern of drug consumption that is causing damage to health. The damage may be physical (as in cases of infections related to drug use) or mental (e.g., episodes of depressive disorder) and is often associated with damage to social functioning (e.g., family problems, legal problems or work-related problems).

**Dual diagnosis**: Having a mental health disorder and an alcohol or drug problem at the same time.
Generalized Anxiety disorder: Anxiety that is generalized and persistent but not restricted to, or even strongly predominating in, any particular environmental circumstances (i.e., it is “free-floating”). It is characterised by excessive anxiety and worry (apprehensive expectation), occurring more days than not for at least 6 months, about a number of events or activities (such as work or school performance). The individual finds it difficult to control the anxiety and worry and it is associated with three (or more) of the following six symptoms (with at least some symptoms having been present for more days than not for the past 6 months): (1) restlessness, feeling keyed up or on edge; (2) being easily fatigued; (3) difficulty concentrating or mind going blank; (4) irritability; (5) muscle tension; (6) sleep disturbance (difficulty falling or staying asleep, or restless, unsatisfying sleep). Importantly, the anxiety, worry, or physical symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning (and it is not attributable to the physiological effects of a substance or another medical condition or the content of delusional beliefs in schizophrenia or delusional disorder).

Hallucinations: They are disorders of sensory perception in the absence of a corresponding external or somatic stimulus and described according to the sensory domain in which it occurs. There are various different types of hallucinations including; auditory (hearing sounds or voices), olfactory (smells), tactile (sensation), visual (seeing things) or gustatory (taste). They may occur with (the individual recognizes as unreal) or without (defines it as a psychotic symptom, that is, a hallucination for which reality testing is impaired) insight into their hallucinatory nature. The most common are hearing voices or seeing things that don’t really exist. Hallucinations are common psychotic disorders. Hallucinations may also occur after illegal drug use and some prescribed drugs (e.g., steroids).

Illusion: Misperception of a sensory stimulus; described according to the sensory domain in which it occurs (e.g., visual, auditory, tactile, olfactory, gustatory, nociceptive…).

Learning Disability: A disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculation. The term includes such conditions as perceptual handicaps, brain injury, and minimal brain dysfunction.

Mental Disorders: Mental disorders comprise a broad range of problems, with different symptoms. They are generally characterized, however, by some combination of
disturbed thoughts, emotions, behaviour and relationships with others. Examples are
depression, anxiety, conduct disorders in children, bipolar disorders and schizophrenia.

**Mental Health Services**: The means by which effective interventions for mental health
are delivered. The way these services are organized has an important bearing on their
effectiveness. Typically, mental health services include outpatient facilities, mental
health day treatment facilities, psychiatric wards in a general hospital, community mental
health teams, supported housing in the community, and mental hospitals.

**Mental Health**: The capacity in an individual to function effectively in society. Mental
health is a concept influenced by biological, environmental, emotional, and cultural
factors and is highly variable in definition, depending on time and place. It is often defined
in practice as the absence of any identifiable or significant mental disorder and
sometimes improperly used as a synonym for mental illness.

**Mental illness** All forms of illness in which psychological, emotional or behavioural
disturbances are the dominating feature. The term is relative and variable in different
cultures, schools of thought and definitions. It includes a wide range of types and
severities.

**Mental impairment** A disorder characterized by the display of an intellectual defect, as
manifested by diminished cognitive, interpersonal, social and vocational effectiveness
and quantitatively evaluated by psychological examination and assessment.

**Mild cognitive impairment**: A minor neurocognitive disorder with modest cognitive
decline from a previous level of performance (not exclusively in the context of a delirium)
in one or more cognitive domains (learning and memory; language; executive function;
complex attention; perceptual motor; or social cognition), not better explained by another
mental disorder (e.g., major depressive disorder, schizophrenia). Importantly, the
cognitive deficits are insufficient to interfere with independence (for example instrumental
activities of daily living such as complex tasks such as paying bills or managing
medications, are preserved), but greater effort, compensatory strategies, or
accommodation may be required to maintain independence. Evidence of decline is
based on concern of the individual, a knowledgeable informant, or the clinician.
Moreover, the performance in standardized neuropsychological testing is typically in the
range of one and two standard deviations below appropriate norms (i.e., between the
third and sixteenth percentiles) on formal testing or equivalent clinical evaluation.
Misuse, drug or alcohol: Use of a substance for a purpose not consistent with legal or medical guidelines, as in the non-medical use of prescription medications. The term is preferred by some to abuse in the belief that it is less judgemental.

Neurodegenerative diseases: are progressive neurological disorders characterized by death of specific nerve cells, excluding conditions such as ischemia, infection, intoxication, and malignant tumours. Representative examples include Alzheimer’s disease, which is the most common cause of dementia and compromises cognitive and memory functions of patients, and Parkinson’s disease, which is a progressive movement disorder exhibiting symptoms such as tremors, increased muscle tone, and slow movements. Many neurodegenerative diseases are genetically inherited.

Neuroticism: The trait disposition to experience negative affects, including anger, anxiety, self-consciousness, irritability, emotional instability, and depression1. Persons with elevated levels of neuroticism respond poorly to environmental stress, interpret ordinary situations as threatening, and can experience minor frustrations as hopelessly overwhelming.

Psychiatry: The branch of medicine that deals with the diagnosis, treatment and prevention of mental and emotional disorders. Those who specialize in care of older adults are called geriatric psychiatrists, old-age psychiatrists, psychogeriatricians or geropsychiatrists.

Psychoactive drug or substance: A substance that, when ingested, affects mental processes, e.g., cognition or affect. "Psychoactive" does not necessarily imply dependence-producing, and in common parlance, the term is often left unstated, as in "drug use" or "substance abuse".

Psychology: Profession dealing with peoples’ behaviour and cognition and their effects.

Psychosis: Characterized by distortions of thinking and perception, as well as inappropriate or narrowed range of emotions. Incoherent or irrelevant speech may be present. Hallucinations (hearing voices or seeing things that are not there), delusions (fixed, false idiosyncratic beliefs) or excessive and unwarranted suspicions may also occur. Severe abnormalities of behaviour, such as disorganized behaviour, agitation, excitement and inactivity or overactivity, may be seen. Disturbance of emotions, such as marked apathy or disconnect between reported emotion and observed affect (such as facial expressions and body language), may also be detected. People with psychosis are at high risk of exposure to human rights violations.
Psychosocial disabilities: Refer to people who have received a mental health diagnosis, and who have experienced negative social factors including stigma, discrimination and exclusion. People living with psychosocial disabilities include ex-users, current users of the mental health care services, as well as persons that identify themselves as survivors of these services or with the psychosocial disability itself.

Psychosocial epidemiology: A psychosocial framework directs attention to both behavioural and endogenous biological responses to human interactions. At issue is the “health-damaging potential of psychological stress”, as “generated by despairing circumstances, insurmountable tasks, or lack of social support”. Typically conceptualised in relation to individuals, its central hypothesis is that chronic and acute social stressors: (a) alter host susceptibility or become directly pathogenic by affecting neuroendocrine function, and/or (b) induce health damaging behaviours (especially in relation to use of psychoactive substances, diet and sexual behaviours).

Psychotherapy: Psychological (as opposed to physical) methods of treatment for mental disorders and psychological problems.

Stigma: A distinguishing mark establishing a demarcation between the stigmatized person and others attributing negative characteristics to this person. The stigma attached to mental illness often leads to social exclusion and discrimination and creates an additional burden for the affected individual.
Chapter 5

Neuroscience: methodologies - Glossary
5. Neuroscience: methodologies - Glossary

This glossary contains technical terms related to the most common methodologies used in human neuroscience and relevant to the eMOTIONAL Cities project.

5.1 Functional magnetic resonance (fMRI)

**Acetylcholine**: An excitatory neurotransmitter whose many functions include arousal, muscle activation, memory

**3D-MPRAGE**: A data acquisition sequence that produces detailed, three-dimensional high-resolution structural images of the brain.

**Acquisition matrix**: Number of independent data samples in each direction, e.g., in 2DFT imaging it is the number of samples in the phase-encoding and frequency-encoding directions, and in reconstruction from projections imaging it is the number of samples in time and angle. The acquisition matrix may be asymmetric and of different size than the reconstructed image or display matrix, e.g., with zero filling or interpolation, or (for asymmetric sampling) by exploiting the symmetry of the data matrix. For symmetric sampling, the acquisition matrix will roughly equal the ratio of image field of view to spatial resolution along the corresponding direction (depending on filtering and other processing).

**Acquisition window**: Time in the MR pulse sequence during which the MR signal is recorded. The duration can be denoted TAD (for “time of analog to digital conversion”).

**Aliasing**: Consequence of sampling the MR signal in which any components of the signal that are at a higher frequency than the Nyquist limit will be “folded” in the spectrum so that they appear to be at a lower frequency. In Fourier transform imaging this can produce an apparent wrapping around to the opposite side within the image of a portion of the object that extends beyond the edge of the reconstructed region.

**Analog to digital converter (ADC)**: Part of the interface that converts ordinary (analog) signals, such as the current in an MR receiver coil, into a digital number form, that can be stored and read by the computer. Also commonly termed digitizer.

**Angular frequency (ω)**: Frequency of oscillation or rotation (measured, e.g., in radians/second) commonly designated by the Greek letter omega: $\omega = 2\pi f$, where $f$ is frequency in hertz (Hz).
Angular momentum: A vector quantity given by the vector product of the momentum of a particle and its position vector. In the absence of external forces, the angular momentum remains constant, with the result that any rotating body tends to maintain the same axis of rotation. In the presence of a torque applied to a rotating body in such a way as to change the direction of the rotation axis, the resulting change in angular momentum results in precession. Atomic nuclei possess an intrinsic angular momentum referred to as spin, measured in multiples of Planck’s constant.

Annotation: A description of the factors used in creating an MR image. Appropriate annotation should include the type and times of the pulse sequence, the number of signals averaged or added (NSA), the size of the reconstructed region, the size of the acquisition matrix in each direction, and the slice thickness.

Anterior: Toward the front of the brain (see rostral).

Anterior to posterior commissure (AC-PC): The anterior commissure (AC) and posterior commissure (PC) are two structures in the brain that are used to define the Talairach coordinate system of the human brain. The anterior commissure is defined as the origin with coordinates (0, 0, 0).

Apodization: Multiplication of acquired MR data by a function smoothly tapering off at higher spatial frequencies so as to reduce “ringing” artifacts near edges in the corresponding image or spectrum due to truncation and Gibbs phenomenon. It is a form of filtering.

Asymmetric sampling: The collection of more data points on one side of the k-space origin than on the other. With fewer k-space data points prior to the centre (echo) a shorter echo time can be attained. Asymmetric acquisition in any phase encoding direction followed by partial-Fourier reconstruction leads to a reduction in imaging time.

Axial plane (or slice): See Transverse plane or transaxial plane.

B, field: The static magnetic field generated by the MRI scanner.

B, field: The magnetic field caused by the introduction of energy into the scanner system.

Bandwidth: A general term referring to a range of frequencies (e.g., contained in a signal or passed by a signal processing system).

Baseline: A generally smooth background curve with respect to which either the integrals or peak heights of the resonance spectral lines in the spectrum are measured.

Baseline condition: Experimental condition designed to provide a baseline measure of brain activity. Since fMRI measures relative states of regional blood flow, such conditions
are essential. Common baseline conditions include eyes closed, or fixation (looking at a central point or cross with eyes open).

**Baseline correction:** Processing of the spectrum to suppress baseline deviations from zero that may be superimposed on desired spectral lines. These deviations may be due either to various instrumental effects or to very broad spectral lines.

**Bloch equation:** The equation that describes how the net magnetization of a tissue changes over time. The Bloch equation is the sum of three terms: a precession term, involving the gyromagnetic ratio and the field strength; a T1 term; and a T2 term.

**Block:** A block is a temporally contiguous period when a subject is presented with a particular condition. A group of experimental trials.

**Blood oxygen level dependent effect (BOLD):** A change in MRI-measurable signal caused by changes in the amount of oxygenated haemoglobin available in the venous circulation of the brain. Oxygenated haemoglobin has a smaller magnetic susceptibility than deoxygenated haemoglobin. Neural activity causes replacement of deoxygenated haemoglobin by oxygenated haemoglobin, which has higher T2* due to its smaller magnetic susceptibility. As T2* increases, higher signal is measured on T2*-weighted gradient echo images, yielding a positive signal of increased venous circulation.

**Brodmann Area (BA):** Brodmann divided the cortex into areas which differ from one another in the cell types and microscopic organization. This differentiation has been used as a basis for characterizing and labelling different cortical regions. Areas are numbered from 1 to 52.

**Caudal:** Toward the back of the brain.

**Cerebral blood flow (CBF):** The flow of capillary blood through the cortex, measured in units of flow (millilitres per minute) per unit mass of cortex.

**Cerebral blood volume (CBV):** The volume of blood in a given volume of cerebral cortex, measured in units of volume.

**Cerebral cortex:** The outermost layer of the brain. In humans it is 2–4 mm thick and has a convoluted topography, created by sulci and gyri. It is often classified into four lobes, the frontal, parietal, temporal, and occipital lobe. The cerebral cortex plays a key role in cognitive processes, e.g., memory, language, attention, consciousness.

**Cluster threshold:** A method for controlling inflation of false positives due to the fact that in a given contrast statistical comparisons are calculated for every voxel, thus resulting in a large number of statistical tests within the same experiment.
Coil: Single or multiple loops of wire (or other electrical conductor, such as tubing, etc.) designed either to produce a magnetic field from current flowing through the wire, or to detect a changing magnetic field by voltage induced in the wire.

Condition: A set of task features that are created to engage a particular mental state. An experimental condition is one of several variations in the independent variable, which is expected to produce a change in the dependent variable.

Contrast: (1) In conventional radiography, contrast is defined as the difference of the signal intensities divided by the average signal intensity in two adjacent regions. In a general sense, we can consider image contrast, where the strength of the image intensity in adjacent regions of the image is compared, or object contrast, where the relative values of a parameter affecting the image (such as spin density or relaxation time) in corresponding adjacent regions of the object are compared. (2) In fMRI, a contrast refers to a difference in brain activation between experimental conditions.

Contrast-to-noise ratio: Ratio of the absolute difference in intensities between two regions to the level of fluctuations in intensity due to noise.

Coronal plane (slice): The plane defined by the head-to-foot and left-to-right directions in the human body. A stack of images acquired in the coronal plane separates images by their anterior-to-posterior locations.

Crosstalk: The phenomenon by which radiofrequency pulses that are applied to adjacent slice positions excite the same region of tissue, resulting in contamination of the measured signal. Crosstalk is often avoided by leaving a gap between slices and by not acquiring the slices in sequential order.

DC artifact: A bright point created in the image caused by a constant offset in signal intensity of all raw data points.

Decoupling: 1) specific irradiation designed to remove the multiplet structure in a particular resonance due to spin-spin coupling with other nuclei; 2) a means of preventing the interaction by mutual inductive coupling of two (or more) resonant RF coils, e.g., by detuning coils not in use at a particular point in time. Decoupling can take the form of active decoupling where an externally controlled switching circuit is used to detune the non-selected coils or passive decoupling where RF energy from the transmitter pulse is used to switch diodes to detune the appropriate coil.

$\Delta x, \Delta y, \Delta z$. The pixel size (not necessarily equal to the resolution) along the x, y, or z axis.
**Deoxyhemoglobin Haemoglobin**: (the protein in red blood cells) without oxygen (“blue blood”). Deoxyhaemoglobin is paramagnetic.

**Dephasing**: The loss of magnetization in the transverse plane, typically due to the fact that different magnetic dipoles of different nuclei are precessing about the main magnetic field, $B_0$, at slightly different precessional frequencies and therefore lose phase coherence.

**Diamagnetism**: Having a weak repulsion from a magnetic field. Most tissues in the body are diamagnetic. When diamagnetic substances are placed in an external magnetic field, the effective strength of the field is reduced.

**Diffusion**: The process by which molecules or other particles intermingle and migrate due to their random thermal motion. NMR provides a sensitive technique for measuring diffusion of some substances.

**Diffusion-weighted imaging (DWI)**: Imaging techniques designed to weight the measured MRI signal by the amount of diffusion (random thermal motion) of water molecules in the selected voxels.

**Digital to analog converter (DAC)**: Part of the interface that converts digital numbers from the computer into analog (ordinary) voltages or currents.

**Digitization**: Process of conversion of continuous (analog) signals, such as the detected MR signal (voltage), into numbers. This is carried out with an analog to digital converter. There are two kinds of discretization involved: the voltage is only measured (sampled) at particular discrete times, and only voltages within a particular range and separated by a particular minimum amount can be distinguished. Voltages beyond this range are said to exceed the dynamic range of the digitizer.

**Dorsal**: Toward the top of the brain.

**Dynamic range**: Range of signal intensities that may need to be distinguished in an image or spectrum or that can be distinguished by the electronic components. If the signal dynamic range is too great, the need to keep the highest intensities from overloading the digitizer may result in the weaker features being lost in the digitization noise. This can be dealt with by using an analog to digital converter with a larger range of sensitivity or by using techniques to reduce the dynamic range, e.g., suppressing the signal from water in order to detect the signal from less abundant compounds.

**Echo planar imaging (EPI)**: A single-shot gradient echo or spin echo imaging technique that collects a complete 2D image data set with Cartesian k-space coverage from a
single excitation. For example, the FID is observed while periodically switching the y-magnetic field gradient in the presence of a static magnetic field gradient. The Fourier transform of the resulting spin echo train can be used to produce an image of the excited plane.

**Echo train length (ETL):** The number of echoes combined into a single image or image set in multiple echo imaging sequences or echo-train techniques such as rapid acquisition with relaxation enhancement (RARE), fast-spin echo (FSE), and turbo spin-echo (TSE). In RARE imaging, the ETL typically equals the acceleration factor.

**Epoch:** In the context of fMRI, this term is often used to refer to a portion of a single fMRI run during which the stimulus presentation and/or response task is unchanged. (Note that “unchanged” does not mean that the stimulation is necessarily static, but that it is treated as a single type of stimulus. For instance, the visual presentation of flickering or moving dots is changing with time, but a 30-second period during which such stimuli were presented continuously would normally be considered a single “epoch”. Further complicating the terminology is the fact that what counts as a single epoch of stimulation is somewhat arbitrarily defined by the experimental design. A sequence of visually presented faces might be treated as a single “epoch” in the context of general face processing, but might be separable into several epochs based on grouping by gender, age, familiarity, etc. Thus, a given experimental paradigm might be divided into “epochs” for analysis in several different ways.)

**Event:** An isolated occurrence of a stimulus being presented, or a response being made. It is essential to have exact onset timing and duration information in addition to identify the events and when they occurred. Some tasks will not have events however (for example, resting state).

**Event-Related Design:** An experimental design in which the time a stimulus is presented is not fixed and is often (but not necessarily) extremely brief. Also sometimes called Single trial design because each trial is statistically independent of the other trials. To be statistically independent, different trial types must be intermixed so that it is not possible to predict the next trial type from the previous one.

**Excitation:** Putting energy into the spin system; if a net transverse magnetization is produced, an MR signal can be observed.

**Exponential weighting:** In spectroscopy, multiplication of the time-dependent signal data by an exponential function, \( \exp(t/TC) \), where \( t \) is time and \( TC \) is a parameter called the time constant. The time constant can be chosen to either improve the signal-to-noise
ratio (with a negative TC) or decrease the effective spectral line width (with a positive TC) in the resulting spectrum. The use of a negative TC to improve SNR is equivalent to line broadening by convolving the spectrum with a Lorentzian function of corresponding reciprocal width.

**Ferromagnetic:** A substance, such as iron, that has a large positive magnetic susceptibility.

**Field of view (FOV):** The rectangular region superimposed over the human body over which MRI data are acquired. Its dimensions are specified in length in each in-plane direction and are controlled by the application of frequency-encode and phase-encode gradients.

**Filter:** Filtering is any process which alters the relative frequency content. This can be done with an analog (conventional electrical) filter, e.g., to remove higher frequency components so as to avoid aliasing in digitizing. Filtering can be carried out numerically on the digitized data.

**Flip angle:** The change in precession angle from aligning with the z-axis (direction of the magnetic field) to aligning with the transverse (x, y)-plane following application of a pulse. A 90° flip angle flips the net magnetization into the (x,y)-plane; lesser flip angles tilt the net magnetization in the direction of that plane.

**Fluid attenuated inversion recovery (FLAIR):** A pulse sequence used in MRI and can be used in 3D and 2D imaging. This pulse sequence is an inversion recovery technique that nulls fluids. Thus, one can suppress CSF effects on images in order to discover periventricular lesions.

**Frequency encoding:** Encoding the distribution of sources of MR signals along a direction by detecting the signal in the presence of a magnetic field gradient along that direction so that there is a corresponding gradient of resonance frequencies along that direction. In the absence of other position encoding, the Fourier transform of the resulting signal is a one-dimensional projection profile of the object.

**Functional acquisition cycle:** A sequence in which images of the brain are captured. Functional refers to a scanning protocol that favours the measurement of moment-to-moment changes in brain activation, rather than anatomical details.

**Functional magnetic resonance imaging (fMRI):** The use of MRI to study function in addition to anatomy. In the brain, fMRI measures change in cerebral blood flow and
cerebral blood oxygenation as correlates of neuronal activity. fMRI is also used to study function of the heart and other organs.

G_x, G_y, G_z: Conventional symbols for magnetic field gradient. Used with subscripts to denote spatial direction component of gradient, i.e., direction along which the field changes.

Gap: The space left between consecutive slices of data. Used to limit crosstalk.

Gaussian noise: Noise distributed in a normal (Gaussian) pattern. In such a distribution, approximately 65% of all points fall within one standard deviation (s) of the mean.

Gaussian smoothing kernel: Gaussian smoothing kernels are applied to fMRI data to remove signal fluctuations that deviate from a normal distribution. By applying Gaussian smoothing kernels, researchers ensure that the data they are modelling follow a normal distribution and can thus be subjected to parametric statistics.

General Linear Model: The general linear model is a statistical tool for quantifying the relationship between several independent and several dependent variables. It's a sort of extension of multiple regression, which is itself an extension of simple linear regression. The model assumes that the effects of different independent variables on a dependent variable can be modelled as linear, which sum in a standard linear-type fashion. The standard GLM equation is \( Y = BX + E \), where \( Y \) is signal, \( X \) is your design matrix, \( B \) is a vector of beta weights, and \( E \) is error unaccounted for by the model. Most neuroimaging software packages use the GLM as their basic model for fMRI data, and it has been a very effective tool at testing many effects. Other forms of discovering experimental effects exist, notably non-model-based methods like principal components analysis.

Gibbs phenomenon: Artefactual ripples that occur near a discontinuity when reconstructing a mathematical function from only a finite portion of its Fourier transform. In MR imaging, it can be seen as linear artifacts parallel to sharp edges in the object, particularly with the use of zero filling.

Global effects: Any change in your fMRI signal that affects the whole brain (or whole volume) at once. Sources of these effects can be external (scanner drift, etc.) or physiological (motion, respiration, etc.). They are generally taken to be non-neuronal in nature, and so generally you’d like to remove any global effects from your signal, since it’s extremely unlikely to be caused by any actual neuronal firing.

Gradient: The amount and direction of the rate of change in space of some quantity, such as magnetic field strength. Also commonly used to refer to magnetic field gradient.
**Gradient-echo:** A signal echo produced by reversing the direction of a magnetic field gradient or by applying balanced pulses of magnetic field gradient before and after a refocusing RF pulse so as to cancel out the position-dependent phase shifts that have accumulated due to the gradient. In the latter case, the gradient echo is generally adjusted to be coincident with the RF spin echo. When the RF and gradient echoes are not coincident, the time of the gradient echo is denoted TE and the difference in time between the echoes is denoted TD, while TER refers to the time of the RF spin echo.

**Gradient echo planar imaging sequence (EPI):** A data acquisition procedure that is sensitive to the BOLD contrast and that permits very rapid acquisition of fMRI with multiple images collected at the same time.

**Gradient-echo pulse sequence:** A pulse sequence that relies on gradient reversal to rephrase the transverse magnetization. Gradient-echo pulse sequences permit small flip-angle excitations, which preserve most of the longitudinal magnetization and therefore reduce or eliminate the time required for recovery of longitudinal magnetization before repeating the pulse sequence. Gradient echo pulse sequences have gained common use in 2DFT (planar) and 3DFT (volume) imaging, flow imaging, magnetic susceptibility imaging, and BOLD imaging.

**Gray matter:** The tissue in the brain in which neural activity takes place. Areas in gray matter consist of nerve cell bodies with no myelin (fatty) covering.

**Gyrus:** A ridge in the surface of the cerebral cortex. It is surrounded by sulci.

**Inter-stimulus interval (ISI):** Time between consecutive stimuli.

**Hemodynamic response:** Changes in blood flow, blood volume, and blood oxygenation as a result of local neural activity.

**Homogeneity:** Uniformity. In MR, the homogeneity of the static magnetic field is an important criterion of the quality of the magnet. Homogeneity requirements for MR imaging are generally lower than the homogeneity requirements for NMR spectroscopy, but for most imaging techniques must be maintained over a large region.

**Isotropic Imaging:** Imaging in which voxel dimensions are equal in x, y, and z directions.

**Image acquisition time:** Time required to carry out an MR imaging procedure comprising only the data acquisition time. The total image acquisition time will be equal to the product of the repetition time, TR, the number of signals averaged, NSA, and the number of different signals (encoded for position) to be acquired for use in image reconstruction. The additional image reconstruction time will also be important to
determine how quickly the image can be viewed. In comparing sequential plane imaging and volume imaging techniques, the equivalent image acquisition time per slice must be considered as well as the actual image acquisition time.

**Image space:** The space in which the data are viewed. Most statistical analysis takes place in image space.

**Inferior:** Toward the bottom of the brain (see ventral).

**Interpulse times (t):** Times between successive RF pulses used in pulse sequences. Particularly important are the inversion time (TI) in inversion recovery, and the time between 90° pulse and the subsequent 180° pulse to produce a spin echo, which will be approximately one half the spin echo time (TE). The time between repetitions of pulse sequences is the repetition time (TR).

**Inversion-recovery (IR):** Pulsed MR imaging sequence wherein the nuclear magnetization is inverted at a time on the order of T1 before the regular imaging pulse-gradient sequences. The resulting partial relaxation of the spins in the different structures being imaged can be used to produce an image that depends strongly on T1. This may bring out differences in the appearance of structures with different T1 relaxation times. Note that this does not directly produce an image of T1. T1 in a given region can be calculated from the change in the NMR signal from the region due to the inversion pulse compared to the signal with no inversion pulse or an inversion pulse with a different inversion time (TI).

**Isocentre, magnetic:** The position in the magnet which is centred in the x, y, and z direction. At this location the static magnetic field is typically highest in uniformity.

**Isotropic voxel:** A voxel with equal physical dimensions in x, y, and z directions.

**k-space:** Mathematical space in which the Fourier transform of the image is represented. The data acquired for MR image reconstruction generally correspond to samples of k-space, that is, they represent values of the Fourier transform of the image at a particular set of locations in k-space.

**Lateral:** Away from the middle of the brain; toward the edge of the brain.

**Localization techniques:** Means of selecting a restricted region from which the signal is received. These can include the use of surface coils, with or without magnetic field gradients. Generally used to produce a spectrum from the desired region.
Longitudinal magnetization ($M_z$): Component of the macroscopic magnetization vector along the static magnetic field. Following excitation by RF pulse, $M_z$ will approach its equilibrium value $M_0$, with a characteristic time constant $T_1$.

Longitudinal relaxation: Return of longitudinal magnetization to its equilibrium value after excitation; requires exchange of energy between the nuclear spins and the lattice.

Magnetic dipole: North and south magnetic poles separated by a finite distance. An electric current loop, including the effective current of a spinning nucleon or nucleus, can create an equivalent magnetic dipole.

Magnetic field ($H$): The region surrounding a magnet (or current carrying conductor) is endowed with certain properties. One is that a small magnet in such a region experiences a torque that tends to align it in a given direction. Magnetic field is a vector quantity; the direction of the field is defined as the direction that the north pole of the small magnet points when in equilibrium. A magnetic field produces a magnetizing force on a body within it. Although the dangers of large magnetic fields are largely hypothetical, this is an area of potential concern for safety limits. Formally, the forces experienced by moving charged particles, current carrying wires, and small magnets in the vicinity of magnet are due to magnetic induction ($B$), which includes the effect of magnetization, while the magnetic field ($H$) is defined so as not to include magnetization. However, both $B$ and $H$ are often loosely used to denote magnetic fields.

Magnetic forces: Forces resulting from the interaction of magnetic fields. Pulsed magnetic field gradients can interact with the main magnetic field to produce acoustic noise through the gradient coil. Magnetic fields attract ferromagnetic objects with forces which can be lethal if one is hit by an unrestrained object in flight. One could also be trapped between the magnet and a large unrestrained ferromagnetic object, or the object could damage the MR system. Access control and personnel awareness are the best prevention of such accidents. The attraction mechanism for ferromagnetic objects is that the magnetic field magnetizes the iron. This induced magnetization reacts with the gradient of the magnetic field to produce an attraction toward the strongest area of the field. The details of this interaction are very dependent on the shape and composition of the attracted object. There is a very rapid increase of force as one approaches a magnet. There is also a torque or twisting force on objects, e.g., a long cylinder (such as a pen or an intracranial aneurysm clip) will tend to align along the magnet’s field lines. The torque increases with field strength while the attraction increases with field gradient. Depending on the magnetic saturation of the object, attraction is roughly proportional to object mass.
Motion of conducting objects in magnetic fields can induce eddy currents that can have the effect of opposing the motion.

**Magnetic resonance (MR):** Resonance phenomenon resulting in the absorption and/or emission of electromagnetic energy by nuclei or electrons in a static magnetic field, after excitation by a suitable RF magnetic field. The peak resonance frequency is proportional to the magnetic field and is given by the Larmor equation. Only unpaired electrons or nuclei with a non-zero spin exhibit magnetic resonance.

**Magnetic resonance imaging (MRI):** Use of magnetic resonance to create images of objects such as the body. Currently, this primarily involves imaging the distribution of mobile hydrogen nuclei (protons) in the body. The image brightness depends jointly on the spin density (N(H)) and the relaxation times (T1 and T2), with their relative importance depending on the particular imaging technique and choice of interpulse times. Image brightness is also affected by any motion, such as blood flow, respiration...

**Magnetic susceptibility (χ):** Measure of the ability of a substance to become magnetized.

**Magnetization transfer:** The change in magnetization within a multicomponent spin system when one of the component peaks is selectively perturbed. This is observed as a change in relative signal intensities. One of the most common forms of perturbation in imaging is selective saturation. For example, this phenomenon can be exploited as part of an imaging sequence to produce image contrast based on differential amounts of magnetization transfer, magnetization transfer contrast (MTC).

**Matrix size:** The number of data points collected in one, two or all three directions. Normally used for the 2D in-plane sampling. The display matrix may be different from the acquisition matrix, although resolution is determined by the latter.

**Medial:** Toward the middle of the brain.

**MNI coordinates:** x, y, z coordinates which represent the location of a point in the brain on the Montreal Neurological Institute template, which was developed from averaging the brain scans of 305 normal right-handed participants. MNI coordinates are slightly different from Talairach coordinates.

**MPR (multiplanar reconstruction):** The reformatting of a 3D data set into 2D slices of arbitrary thickness at any angle.

**Multi-Parameter Maps:** Multi-Parameter Maps (MPMs) are a structural imaging protocol based on a 3D multi-echo fast low angle shot (FLASH) sequences, typically consisting
of magnetisation transfer weighted (MTw) sequences, a proton density weighted (PDw) sequences and standard T1-weighted (T1w) sequences. MPMs are important for improved segmentation of brain tissue and are of particular high relevance for identifying subcortical brain regions, for example regions of the human midbrain or basal ganglia.

**Multivariate analysis:** Considers multiple decision variables and takes into account patterns of information that might be present across multiple voxels. By accumulating weak information across many spatial locations, the sensitivity of human neuroimaging can be dramatically increased. Single brain regions (without individually carrying information) might carry information when they are jointly analysed. Fine-grained spatial information can be revealed, which is discarded in conventional analyses (due to spatial smoothing). The increased sensitivity of decoding-based approaches potentially allows even quasi-online estimates of a person's perceptual or cognitive state.

**Net magnetization:** The total magnetization of the system at a given time. This is influenced by the external field, as well as any gradient pulses that have been applied.

**Neurological convention:** The display of brain images so that the right side of the image corresponds to the right side of the brain, and the left side of the image corresponds to the left side of the brain.

**Noise:** That component of the reconstructed image (or spectrum) due to random and unpredictable processes as opposed to the signal within the image itself which is due to predictable processes. Not to be confused with artifacts which are non-random errors in the image. It is commonly characterized by the standard deviation of signal intensity in the image of a uniform object (phantom) in the absence of artifacts. The measured noise may depend on the particular phantom used due to variable effects on the Q of the receiver coil.

**Nuclear magnetic moment:** The (small) magnetic field generated by an individual nucleus with nonzero spin.

**Oblique slice:** A view of the brain that is not from any of the three main directional planes (axial, coronal, or sagittal). Oblique slices are obtained by linearly combining the slice selection, phase encoding, and frequency encoding gradients.

**Orientation:** The three basic orthogonal slice orientations are: transverse (T), sagittal (S) and coronal (C). The basic anatomical directions are right (R) to left (L), posterior (P) to anterior (A), and feet (F) to head (H), considered as positive directions. The location in the R/L and P/A directions can be specified relative to the axis of the magnet; the F/H location can be specified relative to a convenient patient structure. A standard display
orientation for images in the basic slice orientation is: 1) transverse: A to top of image and L to right, 2) coronal: H to top of image and L to right and 3) sagittal: H to top of image and A to left. The orientation of single oblique slices can be specified by rotating a slice in one of the basic orientations toward one of the other two basic orthogonal planes about an axis defined by the intersection of the two planes. For example, a plane tipped from the transverse 30° toward the sagittal would be denoted T Ø S 30. Double oblique slices can be specified as the result of tipping a single oblique plane as above toward the remaining basic orientation plane about an axis defined by the intersection of the oblique plane and the remaining basic plane. For example, tipping the single oblique plane above 40° toward the coronal would be denoted (T Ø S 30) Ø C 40. In double oblique angulations, the first rotation is chosen about the vertical image axis and the second about the (new) horizontal axis. Angles are chosen to have magnitudes less than 90° (for single oblique slices less than 45°); the sign of the angle is taken to be positive when the rotation brings positive axes closer together. For a scan including a family of single oblique angulations in a fan, we keep the same primary slice order to denote all the images, choosing it so the average angle is in the range ±45°. Labelling the four sides of the image according to the direction relative to the centre of the image helps clarify anatomical orientation: the basic orientation images will have four single letter labels; single oblique images will have two single and two double letter labels and double oblique images will have two double and two triple letter labels. The order of the letters in the label should reflect the relative closeness of the primary axes. The slice location can be specified by the location of the point at the centre of the slice. In general, the actual displayed image may have a further, in-plane, rotation; this should be indicated either as an angle of rotation (positive, clockwise) or with a graphical icon, as discussed below. An alternate way to specify the orientation of the image plane is with the direction cosines of the normal to the plane (the cosines of the angle between a line perpendicular to the image plane and the basic axes (A, L, H)). This may be convenient when specifying images to be acquired perpendicular to an axis between anatomical landmarks. The labelling of the locations of the sides of the image relative to the image centre would be the same as above for specification of plane orientation by rotations relative to the basic orientation planes. If available, some graphic aids can be helpful to show image orientations. 1) A graphic icon of the labelled primary axes (A, L, H) with relative lengths given by direction sines and orientation as if viewed from the normal to the image plane can help orient the viewer, both to identify image plane orientation and to indicate possible in-plane rotation. 2) In graphic prescription of obliques from other images, a
sample original image with an overlaid line or set of lines indicating the intersection of
the original and oblique image planes can help orient the viewer.

**Oxyhaemoglobin Haemoglobin**: (the protein in red blood cells) that is loaded with
oxygen. Oxyhaemoglobin is bright red in colour.

**Paramagnetic**: A substance with a small but positive magnetic susceptibility
(magnetizability). The addition of a small amount of paramagnetic substance may greatly
reduce the relaxation times of water. Typical paramagnetic substances usually possess
an unpaired electron and include atoms or ions of transition elements, rare earth
elements, some metals, and some molecules including molecular oxygen and free
radicals. Paramagnetic substances are considered promising for use as contrast agents
in MR imaging.

**Partial volume effect**: The loss of contrast between two adjacent tissues in an image
caused by insufficient resolution so that more than one tissue type occupies the same
voxel (or pixel).

**Phase**: In a periodic function (such as rotational or sinusoidal motion), the position
relative to a particular part of the cycle.

**Phase correction**: (1) corrective processing of the spectrum so that spectral lines at
different frequencies all have the absorption-mode phase. (2) in imaging, adjustment of
the signal in different parts of the image to have a consistent phase.

**Phase cycling**: Techniques of signal excitation in which the phases of the exciting or
refocusing RF pulses are systematically varied and the resulting signals are then suitably
combined in order to reduce or eliminate certain artifacts.

**Phase encoding**: Encoding the distribution of sources of MR signals along a direction
in space with different phases by applying a pulsed magnetic field gradient along that
direction prior to detection of the signal. In general, it is necessary to acquire a set of
signals with a suitable set of different phase-encoding gradient pulses in order to
reconstruct the distribution of the sources along the encoded direction.

**Pixel**: Acronym for a picture element; the smallest discrete part of a digital image display.
Note that the corresponding size of the pixel may be smaller than the actual spatial
resolution.

**Planar imaging**: Imaging technique in which the image of a plane is built up from signals
received from the whole plane.

**Posterior**: Toward the back of the brain (see caudal).
**Precession:** Comparatively slow gyration of the axis of a spinning body so as to trace out a cone; caused by the application of a torque tending to change the direction of the rotation axis, and continuously directed at right angles to the plane of the torque. The magnetic moment of a nucleus with spin will experience such a torque when inclined at an angle to the magnetic field, resulting in precession at the Larmor frequency. Familiar examples are the effect of gravity on the motion of a spinning top, gyroscope, or the rotating earth.

**Pulse sequences:** Set of RF (and/or gradient) magnetic field pulses and time spacings between these pulses; used in conjunction with magnetic field gradients and MR signal reception to produce MR images. See also Interpulse times. A recommended shorthand designation of interpulse times used to generate a particular image is to list the repetition time (TR), the echo time (TE) and, if using inversion-recovery, the inversion time, TI, with all times given in milliseconds. For example, 2500/30/1000 would indicate an inversion-recovery pulse sequence with TR of 2500 msec, TE of 30 msec, and TI of 1000 msec. If using multiple spin echoes, as in CPMG, the number of the spin echo used should be stated.

**Radiofrequency (RF) coil:** Coil that transmits or receives RF pulses. RF coils may be transmitters only, receivers only, or both.

**Radiofrequency (RF) pulse:** An insertion of energy into the system that generates a weak magnetic field and “flips” the net magnetization vector into the transverse plane.

**Radiological convention:** The display of brain images so that the right side of the image corresponds to the left side of the brain, and the left side of the image corresponds to the right side of the brain.

**Region-of-interest (ROI):** In fMRI analysis, region of interest refers to a specified area of the brain. Its size and location can be selected according to the underlying research question, based on localizer tasks, anatomical landmarks, relevant findings from the literature, and/or activated brain regions. ROIs are defined for the purpose of further statistical analysis and/or graphic display of the data.

**Relaxation:** The return of an excited system of spinning magnetic dipoles (spins) to its equilibrium state.

**Relaxation rates:** Reciprocals of the relaxation times, T1 and T2 (R1 = 1/T1 and R2 = 1/T2). There is often a linear relation between the concentration of MR contrast agents and the resulting change in relaxation rate.
**Relaxation times:** After excitation, the spins will tend to return to their equilibrium distribution, in which there is no transverse magnetization, and the longitudinal magnetization is at its maximum value and oriented in the direction of the static magnetic field. It is observed that in the absence of applied RF magnetic field, the transverse magnetization decays toward zero with a characteristic time constant T2, and the longitudinal magnetization returns toward the equilibrium value $M_0$ with a characteristic time constant T1.

**Resonance** The result when the frequency of the RF pulse matches the rate of precession of the protons in a region of tissue. Resonance adds energy to the system; without it, the flip of the magnetization vector into the $(x, y)$-plane could not occur.

**Run:** A continuous period of data acquisition that has the same acquisition parameters and task (however events may change from one run to another in relation to different subject responses or because of randomized presentation of the stimuli). A run is essentially the same as data acquisition.

**Rostral:** Toward the front of the brain (see anterior).

**Sagittal plane:** The plane which is defined by the head-to-foot and anterior-to-posterior directions in the human body. A stack of images acquired in the sagittal plane separates images by their left-to-right locations. The mid-line sagittal plane bisects the left and right half of the human body.

**Scan:** In the context of fMRI, this refers to a single, continuous collection of images. One full acquisition of brain imaging data, which produces a three-dimensional matrix of data, with voxels as the unit.

**Segmentation:** partitioning the brain into GM (gray matter), WM (white matter) and CSF (Cerebrospinal fluid).

**Session:** The time that a single subject is in the MR scanner. This is typically about 2 hours for fMRI.

**Signal averaging:** The averaging together of signals acquired under the same or similar conditions so as to suppress the effects of random variations or random artifacts. The number of signals averaged together can be abbreviated NSA.

**Signal-to-noise ratio (SNR or S/N):** Used to describe the relative contributions to a detected signal of the true signal and random superimposed signals (“noise”). One common method to improve (increase) the SNR is to average several measurements of the signal on the expectation that random contributions will tend to cancel out. The SNR
can also be improved by sampling larger volumes (with a corresponding loss of spatial resolution) or, within limits, by increasing the strength of the magnetic field used. Surface coils can also be used to improve local SNR. The SNR will depend, in part, on the electrical properties of the sample or patient being studied.

**Signal suppression:** The elimination or reduction of a particular signal by, for example, the application of a narrow band frequency-selective preparation pulse centred at the resonant frequency of the signal. This can also be accomplished using an inversion recovery technique to null the signal as it recovers its longitudinal magnetization.

**Slice:** The effective physical extent of the “planar” region being imaged.

**Slice profile:** The spatial distribution of sensitivity of the imaging process in the direction perpendicular to the plane of the slice. When the profile deviates appreciably from rectangular, the slice thickness alone may not provide an adequate description.

**Slice selection:** The excitation of spins in a limited planar section of tissue by applying a gradient (the slice-selective gradient) while sending a narrow-band radiofrequency pulse of appropriate frequencies into the subject.

**Slice thickness:** The thickness of a slice. As the slice profile may not be sharp edged, a criterion such as the distance between the points at half the sensitivity of the maximum (FWHM) or the equivalent rectangular width (the width of a rectangular slice profile with the same maximum height and same area) may be useful.

**Spatial frequency:** A dimension of the Fourier transform space (k-space representation of an image), having units of inverse distance. Higher values of spatial frequencies correspond to finer detail in the image.

**Spatial resolution:** The smallest distance between two points in the object that can be distinguished as separate details in the image, generally indicated as a length or a number of black and white line pairs per mm. The specific criterion for resolution to be used depends on the type of test used (e.g., bar pattern or contrast-detail phantom). As the ability to separate or detect objects depends on their contrast and the noise, and the different MR parameters of objects will affect image contrast differently for different imaging techniques, care must be taken in comparing the results of resolution phantom tests of different machines and no single simple measure of resolution can be specified. The resolution may be anisotropic. The resolution may be larger than the size corresponding to the discrete image element (pixel), although it cannot be smaller.
**Spin**: The intrinsic angular momentum of an elementary particle, or system of particles such as a nucleus, that is also responsible for the magnetic moment; or a particle or nucleus possessing such a spin. The spins of nuclei have characteristic fixed values. Pairs of neutrons and protons align to cancel out their spins, so that nuclei with an odd number of neutrons and/or protons will have a net nonzero rotational component characterized by an integer or half integer quantum “nuclear spin number” \(I\).

**Spin echo (SE)**: The RF pulse sequence where a 90° excitation pulse is followed by a 180° refocusing pulse to eliminate field inhomogeneity and chemical shift effects at the echo. RF spin echo would be a more appropriate name.

**Spin echo imaging**: Any of many MR imaging techniques in which the spin echo is used rather than the FID. Can be used to create images that depend strongly on T2 if TE has a value on the order of or greater than T2 of the relevant image details. Note that spin echo imaging does not directly produce an image of T2 distribution. The spin echoes can be produced as a train of multiple echoes, e.g., using the CPMG pulse sequence.

**Static magnetic field**: The strong external magnetic field inside the MR scanner. The strength of this field is a constant, measured in Tesla (T), and is usually 1.5 or 3T for research on humans.

**Statistical Map**: An image based on a statistical parameter computed for each voxel throughout a collection of functional neuroimages. The statistical parameter is ordinarily computed using a grouping of the data based upon the epochs in which they were collected. The value of the statistical parameter can be indicated by its intensity (in a gray-scale map) but is more commonly indicated by a pseudo-colour scale overlayed on the MRI.

**Stimulus**: External event which is presented to a participant in an experiment via a particular sensory modality.

**Sulcus**: A depression/fissure in the surface of the cerebral cortex. It surrounds a gyrus.

**Superior**: Toward the top of the brain (see dorsal).

**Suppression**: One of a number of techniques designed to minimize the contribution of a particular component of the object to the detected signal. For example, commonly used to suppress the strong signal from water in order to detect spectral line from other components.

**Susceptibility artifact**: A distortion in the acquired image due to field inhomogeneities where sinuses (air) and tissue neighbour each other.
**T. or T1 (“T-one”):** Spin-lattice or longitudinal relaxation time; the characteristic time constant for spins to tend to align themselves with the external magnetic field. Starting from zero magnetization in the z direction, the z magnetization will grow to 63% of its final maximum value in a time T1.

**T1-weighted (T1W):** Often used to indicate an image where most of the contrast between tissues or tissue states is due to differences in tissue T1. This term may be misleading in that the potentially important effects of tissue density differences and the range of tissue T1 values are ignored. A T1 contrast state is approached by imaging with a TR short compared to the longest tissue T1 of interest and TE short compared to tissue T2 (to reduce T2 contributions to image contrast). Due to the wide range of T1 and T2 and tissue density values that can be found in the body, an image that is T1-weighted for some tissues may not be so for others.

**T. or T2 (“T-two”):** Spin-spin or transverse relaxation time; the characteristic time constant for loss of phase coherence among spins oriented at an angle to the static magnetic field, due to interactions between the spins, with resulting loss of transverse magnetization and MR signal. Starting from a nonzero value of the magnetization in the xy plane, the xy magnetization will decay so that it loses 63% of its initial values in a time T2, if relaxation is characterized by a simple single exponential decay.

**T2-weighted (T2W):** Often used to indicate an image where most of the contrast between tissues or tissue states is due to differences in tissue T2. This term may be misleading in that the potentially important effects of tissue density differences and the range of tissue T2 values are often ignored. A T2 contrast state is approached by imaging with a TR long compared to tissue T1 (to reduce T1 contribution to image contrast) and a TE between the longest and shortest tissue T2s of interest. A TR greater than 3 times the longest T1 is required for the T1 effect to be less than 5%. Due to the wide range of T1 and T2 and tissue density values that can be found in the body, an image that is T2-weighted for some tissues may not be so for others.

**Talairach Coordinates:** x, y, z coordinates which represent the location of a point in the brain on the atlas published by Talairach, which was created based on post-mortem sectioning of a brain from a single person (it was first developed and presented by J. Talairach in 1967).

**Task:** A set of activities performed by the participant while in the scanner. Tasks usually involve stimuli and responses. Resting state scans should also be considered a task. A task is always performed in connection to one data acquisition. Even if during one
acquisition the subject performed multiple conceptually different behaviours (with different sets of instructions) they will be considered one (combined) task.

**TE:** Echo time. Time between middle of exciting (e.g., 90°) RF pulse and middle of spin echo production. For multiple echos, use TE1, TE2, etc. When the RF spin echo and gradient echo are not coincident in time, TE refers to the time of the gradient spin echo.

**Tesla (T):** The preferred (SI) unit of magnetic flux density. One tesla is equal to 10,000 gauss, the older (CGS) unit.

**TI:** Inversion time. In inversion recovery, time between middle of inverting (180°) RF pulse and middle of the subsequent exciting (90°) pulse to detect amount of longitudinal magnetization.

**Time to repetition (TR):** Repetition time. The period of time between the beginning of a pulse sequence and the beginning of the succeeding (essentially identical) pulse sequence.

**Tissue contrast:** (T1, T2, and T2* weighting) The use of the different values of T1, T2, and T2* in different types of tissue to enhance certain features of the image. T2 weighted images are sensitive to regions filled with fluid, such as tumours and other pathologies. T2* weighted images are sensitive to the amount of deoxyhaemoglobin in the tissue, making them particularly useful for BOLD functional MR. T1 weighting is not a significant factor in fMRI.

**Transaxial plane:** The plane perpendicular to long axis of the human body (head-to-foot). Acquiring images in the transaxial plane acquires a stack of parallel images in the head-to-foot direction. Sometimes referred to as the “axial plane” or “transverse plane”.

**Transverse magnetization (Mxy):** Component of the macroscopic magnetization vector at right angles to the static magnetic field (B0). Precession of the transverse magnetization at the Larmor frequency is responsible for the detectable MR signal. In the absence of externally applied RF magnetic field, the transverse magnetization will decay to zero with a characteristic time constant of T2 or T2*.

**Transverse plane:** The plane perpendicular to long axis of the human body (head-to-foot). Sometimes referred to as the “ transaxial plane” or “axial plane”.

**Transverse relaxation:** The loss of magnetization in the plane perpendicular to the static magnetic field, B0.

**Trial:** A trial (or alternatively “event”) is a temporally isolated period during which a particular condition is presented, or a specific behaviour is observed.
**Univariate analysis:** Considers only single-decision variables at any one time, each individual voxel separately. Studies probe whether the average activity across all task trials during one condition is significantly different from the average activity across all time points during a second condition and acquire a large number of samples of brain to maximize statistical sensitivity.

**Ventral:** Toward the bottom of the brain.

**Volume of interest (VOI):** A user-selected subset of voxels in a three-dimensional dataset.

**Volume imaging:** Imaging techniques in which MR signals are gathered from the whole object volume to be imaged at once, with appropriate encoding pulse RF and gradient sequences to encode positions of the spins. Many sequential plane imaging techniques can be generalized to volume imaging, at least in principle. Advantages include potential improvement in signal-to-noise ratio by including signal from the whole volume at once; disadvantages include a bigger computational task for image reconstruction and longer image acquisition times (although the entire volume can be imaged from the one set of data). Also called simultaneous volume imaging or three-dimensional Fourier transform (3DFT) imaging.

**Voxel:** Three-dimensional spatial element in brain scan data, measured in mm. For example, a 1 mm × 1 mm × 1 mm voxel is a 1 mm cube within the brain image.

**Water-suppression:** The elimination or reduction of water signal from the image by application of a narrow-band frequency-selective pulse centred around the resonant frequency of the tissue.

**White matter:** The part of the brain responsible for transmitting information between areas of gray matter. Consists of nerve cells covered by a fatty myelin sheath.

**x:** Dimension in the stationary (laboratory) frame of reference in the plane orthogonal (at right angles) to the direction of the static magnetic field (B₀ and H₀), z, and orthogonal to y, the other dimension in this plane. This is commonly defined to be in the direction of the frequency-encoding gradient.

**y:** Dimension in the stationary (laboratory) frame of reference in the plane orthogonal to the direction of the static magnetic field (B₀ and H₀), z, and orthogonal to x, the other dimension in this plane. This is commonly defined to be in the direction of the phase-encoding gradient.
z: Dimension in the direction of the static magnetic field ($B_0$ and $H_0$), in both the stationary and rotating frames of reference.

**Zero filling:** Substitution of zeroes for unmeasured data points in order to increase the matrix size of the new data prior to Fourier transformation of MR data. This can be equivalent to performing an interpolation in the transformed data, resulting in pixels smaller than the actual resolution of the image.

### 5.2 Electroencephalography (EEG)

**Activity, EEG:** An EEG wave or sequence of waves of cerebral origin.

**Alpha band:** Frequency band of 8–13 Hz inclusive. Greek letter: $\alpha$.

**Alpha rhythm:** Rhythm at 8–13 Hz inclusive occurring during wakefulness over the posterior regions of the head, generally with maximum amplitudes over the occipital areas. Amplitude varies but is mostly below 50 $\mu$V in the adult, but often much higher in children. Best seen with the eyes closed, during physical relaxation and relative mental inactivity. Blocked or attenuated by attention, especially visual, and mental effort.

**Amplitude, EEG:** Is a measure of the change of EEG signals with respect to the mean value, usually measured in microvolts ($\mu$V), and often expressed as the difference between the maximum and minimum deviation (i.e., peak-to-peak), or in rectified EEG from baseline to peak.

**Analog-to-digital conversion (AD conversion):** Transformation of a continuous, analog signal EEG into its digital representation (a discontinuous series of discrete amplitudes).

**Artifact:** (1) A physiological potential difference due to an extracerebral source present in EEG recordings, such as eye blinks and movements, electrocardiogram (ECG) or muscle contractions (EMG). (2) A modification of the EEG caused by extracerebral factors, such an instrumental distortion or malfunction, movement of the patient, or ambient electrical noise.

**Band:** Range of EEG frequency in a spectrum for a given recording or epoch, i.e., delta, theta, alpha, beta, gamma bands and high frequency oscillations.

**Beta band:** Frequency band of 14–30 Hz inclusive. Greek letter: $\beta$.

**Beta rhythm or activity:** Any EEG rhythm between 14 and 30 Hz (wave duration 33–72 ms). Most characteristically recorded over the fronto-central regions of the head.
during wakefulness. Amplitude of fronto-central beta rhythm varies but is mostly below 30 μV. Blocking or attenuation of the beta rhythm by contralateral movement or tactile stimulation is especially obvious in electrocorticograms. Other beta rhythms are most prominent in other locations or are diffuse, and may be drug-induced (for example, alcohol, barbiturates, benzodiazepines, and intravenous anaesthetic agents).

**Bipolar derivation:** (1) Recording from a pair of exploring electrodes. (2) Method of organizing the linkages of electrodes to recording channels.

**Bipolar montage:** Multiple bipolar channels, with no electrode being common to all channels. In most instances, bipolar channels are linked, i.e., adjacent channels from electrodes along the same line of electrodes, or chain, have one electrode in common; so, the reference electrode (input terminal 2) in one channel becomes the exploring electrode (input terminal 1) in the next channel of the chain.

**Burst:** A group of waves with a minimum of four phases and duration longer than 500 ms which appear and disappear abruptly and are distinguished from background activity by differences in frequency, form, and/or amplitude.

**Channel:** Complete system for the detection, amplification and display of potential differences between a pair of electrodes, or a computed reference (for example, common average reference). Digital EEG machines simulate a multichannel display by tracing several voltage time plots on a visual display.

**Common average reference:** Computational average potential of all or most electrode signals used as a reference electrode.

**Common mode signal:** Common component of the two signals applied to the two input terminals of a differential EEG amplifier.

**Common reference electrode:** A reference electrode that is common to all channels.

**Common reference montage:** A montage in which each of the channels have the same reference electrode.

**Cycle:** The complete sequence of recurrent almost sinusoidal oscillatory potential changes undergone by individual waveform components of regularly repeated EEG waves or complexes.

**Cycles per second (c/s):** Unit of frequency defined as the number of complete cycles in one second. Synonym hertz (Hz).

**Delta band:** band of 0.1–<4 Hz, identified with the Greek letter δ.
**Dipole**: An EEG signal vector produced by a separation of negative (sink) and positive (source) potential poles (or current). A dipole is characterized by its strength, location, and orientation. Depending on their orientation, dipoles can be radial (perpendicular to the surface), tangential (parallel to the surface), or a combination of these (oblique).

**Duration**: (1) The interval from beginning to end of an individual wave or complex. (2) The time that a sequence of waves or complexes or any other distinguishable feature lasts in an EEG record.

**Electrocorticography (ECoG)**: Technique of recording electrical activity of the brain by means of electrodes applied over or implanted into the cerebral cortex.

**Electrode, EEG**: A conducting device applied over or inserted in a region of the scalp or brain.

**Electrode impedance**: Total effective resistance to alternating current (AC), arising from ohmic resistance and reactance. Measured between pairs of electrodes or, in some electroencephalographs, between each individual electrode and all the other electrodes connected in parallel. Expressed in ohms (generally kilo-ohms, kΩ).

**Epoch**: EEG segment with a defined duration. Duration of epochs is determined arbitrarily but should be specified.

**Event-related potential (ERP)**: Refer to long latency responses (>70 ms) associated with an event, such as a deviant stimulus (as in mismatch negativity, P3 or P300), anticipation of a response (as in Bereitschaftspotential), or anticipation of a stimulus demanding a response (as in contingent negative variation). Applied mainly to slow (on account of their lower frequency content) “endogenous” evoked potentials elicited by controlled manipulation of the psychological context. Thought to reflect some aspect of higher sensory processing, and therefore sometimes referred to as “cognitive potentials,” such as attention, expectancy, novelty detection, stimulus salience, target recognition, task relevance, information delivery, decision-making, stimulus evaluation time, template matching, memory, and closure of cognitive epoch.

**Evoked potential (EP)**: Wave or complex elicited by and time-locked to a physiological or nonphysiological stimulus or event, the timing of which can be reliably assessed.

**Frequency**: Number of complete cycles of repetitive waves or complexes in 1 s. Measured in cycles per second (c/s) or Hertz (Hz).

**Gamma band**: Frequency band from >30 to 80 Hz. Greek letter: γ.
**Gamma rhythm or activity:** An EEG rhythm above >30–80 Hz (wave duration 12.5–33 ms).

**Hertz (Hz):** Unit of frequency. Synonym: cycles per second (c/s).

**High frequency filter (or low pass filter):** A circuit that reduces the sensitivity of the EEG signals to relatively high frequencies (for example, above 70 Hz). For each setting of the high frequency filter, this attenuation is expressed as percent reduction in signal amplitude at a given frequency, relative to frequencies unaffected by the filter, i.e., in the mid-frequency band of the signal. Synonym: **low pass filter.**

**High pass filter Synonym:** low frequency filter.

**In-phase signals:** Waves with no phase difference between them.

**Inter-electrode distance:** Spacing between pairs of electrodes.

**Lateralized:** Independently involving the right and/or left side of the head (or body). In EEG, a differential activity of the left and right hemisphere is often indexed by the asymmetric spectral power in the alpha (8-13 Hz) frequency bands or differences in the amplitude of the EP signal in respective (e.g., frontal or, temporal) regions. More alpha power over left than right hemisphere has been associated with uncomfort and avoidance, and vice-versa, less alpha power over left than right hemisphere presumably indicates positive emotions and approach motivation.

**Low frequency filter (high pass filter):** A circuit that reduces the sensitivity of the EEG signal to relatively low frequencies (for example, below 0.5 Hz). For each position of the low frequency filter control, this attenuation is expressed as percent reduction of the signal at a given stated frequency, relative to frequencies unaffected by the filter, i.e., in the mid-frequency band of the channel.

**Montage:** The arrangement or array of channels on the EEG machine display, defined by the exploring and reference electrodes.

**Mu rhythm:** Rhythm at 7–11 Hz, composed of archshaped waves occurring over the central or centro-parietal regions of the scalp during wakefulness. Amplitude varies but is mostly below 50 μV. Blocked or attenuated most clearly by contralateral movement, thought of movement, readiness to move or tactile stimulation. Greek letter: μ.

**Notch filter:** A filter that selectively attenuates a very narrow frequency band, thus producing a sharp notch in the frequency response of an EEG signal. Commonly applied to attenuate electrical noise from mains interference (the frequency of which differs
between countries, 50 or 60 Hz), which may occur under unfavourable technical conditions.

**Nyquist theorem:** Accurate digital representation of an EEG signal requires that the sampling rate is at least twice the highest frequency of the signal, i.e., a frequency component of 30 Hz requires at least a sampling rate of 60 Hz.

**Pattern:** Any characteristic regular or repetitive EEG activity of approximately constant period.

**Peak:** Point of maximum amplitude of a wave.

**Period:** Duration of complete cycle of individual graphoelement in a sequence of regularly repeated EEG waves or complexes. Periodic Applies to: (1) EEG waves or complexes occurring in a sequence at an approximately regular rate, (2) EEG waves or complexes occurring intermittently at approximately regular intervals, generally of one to several seconds.

**Phase:** (1) Time or polarity relationships between a point on a wave displayed in a derivation and the identical point on the same wave recorded simultaneously in another derivation. (2) Time or angular relationships between a point on a wave and the onset of the cycle of the same wave. Usually expressed in degrees or radians.

**Photic stimulation:** Delivery of intermittent flashes of light to the eyes of a subject, usually from 1 to 60 Hz. Used as EEG activation procedure.

**Polarity:** convention International agreement whereby differential EEG amplifiers are constructed so that negativity at input terminal 1 relative to input terminal 2 of the same amplifier results in an upward trace deflection.

**Polarity:** EEG wave Sign of potential difference, either positive or negative, existing at a given time between one electrode and another electrode; which may be an exploring and reference electrode in a referential derivation, or two exploring electrodes in a bipolar derivation.

**Polysomnography (PSG):** Polygraphic recording of sleep including EEG, electrooculogram, electromyogram (chin and leg), airflow parameters, and oxygen saturation, along with video. A test used to diagnose sleep disorders.

**Potential:** (1) Strictly: voltage. (2) Loosely: synonym of electrical activity (waveforms) generated by the nervous system.
Power Spectrum: Display of the distribution of frequency specific power (i.e., amplitude squared), with the waveform frequency plotted on the abscissa and the power plotted on the ordinate of a spectrogram display.

Quantitative EEG (qEEG): Processing and analysis of portions of digitized EEG data, such as frequency-specific power typically derived by Fourier transform, displayed in various formats. Statistical variables can be compared, such as wave phase and coherence.

Reference electrode: (1) In general: any electrode against which the potential variations of another electrode are measured. (2) Specifically: a suitable reference electrode is historically connected to the input terminal 2 of an EEG amplifier and placed so as to minimize the likelihood of recording the same EEG activity as detected by an exploring electrode (connected to the input terminal 1 of the same amplifier), or of other activities.

Rhythm: EEG activity consisting of waves of approximately constant period.

Sampling rate: Frequency in Hz used for sampling the digital EEG. Sampling rates in the 250–500 Hz range are common. Higher sampling rates may be appropriate for specific applications, for example, 1000–2000 Hz in intra-cranial depth EEG.

Sensitivity: Ratio of input voltage to output trace deflection in an EEG channel. Sensitivity is measured in microvolts per millimetre (μV/mm). Example: Sensitivity = input voltage/output trace deflection = 50 μV/10 mm = 5 μV/mm.

Sinusoidal Term: applies to EEG waves resembling sine waves.

Somatosensory evoked potential (SEP): Evoked potential in response to somatosensory stimulus, usually electrical stimulation of a sensory or mixed nerve.

Stereotactic (stereotaxic) electroencephalogram (SEEG): Intracerebral EEG recordings using electrodes implanted stereotactically, thus permitting the calculation of electrode coordinates that can be projected on a stereotactic brain atlas or magnetic resonance images to create three-dimensional pictures.

Synchrony: The simultaneous occurrence of EEG waves over distinct regions on the same or opposite sides of the head with the same speed and phase.

Ten-ten (10–10) system: System of standardized scalp electrode placement. According to this system, additional scalp electrodes are placed at half distance between the standard electrodes of the ten-twenty system, i.e., 10 percentile increments of the reference curve.
Ten-twenty (10–20) system: System of standardized scalp electrode placement recommended by the International Federation of Clinical Neurophysiology. According to this system, the placement of electrodes is determined by measuring the head from 4 external landmarks and taking 10 or 20 percentiles of these measurements.

**Theta band:** Frequency band from 4 to <8 Hz. Greek letter: θ.

**Theta rhythm:** Rhythm with a frequency of 4−<8 Hz.

**Voltage:** The difference in electric potential between two points (units: volts).

**Volume conduction:** The passive process by which electrical activity, originating from a generator, spreads through a conductive medium to be detected quite widely by distant (i.e., far-field) recording electrodes, without being mediated by neural activity.

**Wave:** Any change of the potential difference between pairs of electrodes in EEG recording, which may arise in the brain (an EEG wave) or outside of it (i.e., extracerebral potential).

**Waveform (wave form):** The shape or morphology of an EEG wave.

### 5.3 Other neuroscience-related methodologies

**Electrodermal response (EDR):** Also known as a skin conductance response SCR, or galvanic skin response, GSR) is a sympathetic nervous system activated increase in skin conductance of electricity as a response to presentation of arousing stimuli. The response is mediated by the eccrine sweat glands, distributed across the body but are the densest on the palms, and react to the changes in temperature, but also to cognitive and emotional stimuli. Basically, the higher the arousal, the higher the skin conductance.

**Experience sampling method (ESM):** Also known as daily diary method, or ecological momentary assessment (EMA), it is an intensive research procedure for studying what people do, feel, and think during their daily lives. It delivers signals at random occasions during the waking hours and collects real-time reports on them.

**Direction of the gaze:** To see clearly, we need to move our eyes. Direction of the gaze typically indicates overt attention, i.e., shows what is picked up from the environment. Eye movements are cognitively directed: they jump to the events, objects or stimuli in the environment that catch our attention. Such jumping eye movements are saccades.

**Facial Action Coding System (FACS):** Comprehensive, anatomically based system to measure facial behaviour. It was originally created to measure facial expressions of
emotions but can be used to measure any facial behaviour from speech to chewing, allowing objective classification of facial expressions and behaviour.

**Heart rate variability (HRV):** HRV is simply the variation in time between each heartbeat. HRV is a measure of the continuous interplay between sympathetic and parasympathetic influences on heart rate. High HRV refers to emotion regulation, attention and decision making, and better emotional well-being.

**Observation:** method in which an investigator systematically records behaviour as far as possible without influencing it. The method presumes detailed procedures for reliable and valid data collection and interpretation.

**Pupillary reaction:** The diameter of the pupil is controlled by the muscles within the iris, its dilation/contraction reflects in addition to changes in lighting conditions also emotional processing (mostly arousal) and cognitive load. Both increase pupil size (dilation). Thus, eyes can be viewed as a window to the brain.

**Questionnaire:** A research tool in a survey research enabling to collect data from big samples simultaneously. Often consists of standardized questions and scoring, and its administration follows standardized procedures.

**Thermography:** A technique to measure remotely temperature of the skin (e.g., body or face) that decreases/ increases due to vasoconstriction/vasodilation leading to a reduction/increase of blood flow to the peripheral capillaries, respectively. Increase in temperature refers to mental workload, emotions and stress.
Chapter 6

References
6. References

6.1 Urban Environments and Health


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6.2 Neuroscience: cognition and emotion


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6.3 Neuroscience: methodologies


eMOTIONAL CITIES
Mapping the cities through the senses of those who make them