Preface

This is an example overview of the compulsory study material for the exam of the course Research Methods I. It contains a summary of the first three book chapters the students are meant to study for the exam of the course.

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A. Curiosity, creativity and commitment

Science
Psychology is a scientific study of behavior. Science helps us learn about the world. In science we use systematic, rational and observation processes, to acquire new information and knowledge. Scientists search for new knowledge by creating new problem definitions. The fundamental idea of science: **scientific research** is a process of creating a new and specific question, whereupon they search for answers. Science is a way of thinking - this is called a **process of inquiry.** Science is about asking questions. To get answer to these questions, a lot of laboratory equipment and tools are used.

The essence of science is its way of thinking and the disciplined ways in which scientists pose and answer questions. Logical procedures and demands for evidence, not technologies, lie at the center of science. Keep this in mind: science is an intellectual process aimed at understanding the natural universe.

Asking questions
Asking questions is one side of an idea; on the other side an unknown - a potential answer. Asking 'what', 'how' and 'why' is important in scientific research. Asking skeptical questions can be risky. Socrates asked people repeatedly about religion, politics and moral, even when they thought they knew the answers. Socrates was seen as subversive and as a corrupter to youth by asking uncomfortable questions. Socrates eventually got executed. By asking questions, you can create political and social tension. Scientists are pervasive **skeptics.** They challenge accepted knowledge and are looking for more complete answers. It was J. Robert Pappenheimer (1956) who said that scientific research is a reaction to the primitive and permanent presence of human curiosity. Lines Paling (1981) and B.F. Spinner (1956) state that satisfying one's curiosity is one of life's greatest sources of happiness.

Serendipity
Serendipity has come to mean unanticipated discoveries. Attentiveness, curiosity and a **prepared mind** helped discover these unanticipated discoveries. One of these discoveries is penicillin, discovered by Fleming.

Science and art
Scientists and artists are not the same. However, they are not as different as many people think. Scientist and artists have a few characteristics in common. Some of these characteristics are curiosity, creativity, skepticism, hard work, tolerance for ambiguity and systematic thinking. Leonardo da Vinci showed us that science and art can complement one another, by using math, anatomy, mechanics, paint art and sculptures.

Acquiring knowledge
There are many different ways to acquire knowledge. Science is one way of acquiring knowledge. Others are intuition, tenacity and authority. These methods differ in the demands they make on the adequacy of the information and on how they process the information.

Science, which combines rationalism and empiricism, is the most demanding method for acquiring knowledge, whereas intuition, tenacity, and authority make few demands on information and require minimal processing.

Intuition
Intuition is the (supposedly) direct acquisition of knowledge, without intellectual of sensory processing of information. It is common to use intuition in daily life and intuition comes in handy. Most of the time people have a particular feeling about someone they just met. Intuition can lead to making mistakes. There isn't proof for these thoughts and these thoughts aren't well considered. Religious and spiritual people often use intuition, without using their intelligence.

Tenacity
Tenacity is accepting and preserving ideas, even if there is proof that support another idea or if there isn't evidence for the ideas. Ideas that have long been accepted and repeated frequently are generally always accepted as true. In the end, the correctness of the ideas is not controlled by skeptical, critical and objective review and alternative ideas are not seriously considered. In political campaigns, persistence is used by repeatedly repeating deformed ideas, so voters accept them as truth. Advertisers are persistence in what they are telling. They hope one day consumers will accept their information as true.

Authority
Authority is the acceptance of ideas and knowledge because it is given by a respected source such as the Quran, the Bible, the president, a professor or the king.

These three ways of acquiring knowledge include accepting information without developing a critical look. An idea is assumed to be true, because 1) people have always perceived this idea as true, 2) feel the idea is true and 3) an authority says this idea is true.

Rationalism
Rationalism is a way of obtaining information through reasoning. The conclusion is drawn by logic: systematic rules, which make people reach the right conclusions based on a number of facts or statements. The logic is to look at the major and minor premises. Both of these must be correct in order to make the conclusion of rationalism correct.

An example of logic is syllogism:
- All crows are black (major premise);
- This is a crow (minor premise);
- Therefore, this crow is black (conclusion).

Empiricism
Empiricism is based on acquiring knowledge through experience, observation and the use of all senses. The idea of empiricism is: 'I do not believe it until I see it'. This distinguishes two types of empiricism. The two types of empiricism are not used separately, but they are combined with each other to come up with ideas.
- **Naïve empiricism**: the idea "I believe it only when I see it" is taken literally. This has many remarks, because in this case all countries, places and objects that have never been seen would not exist. In optical illusions you also see something that actually does not exist, but you do observe.
- **Sophisticated empiricism**: looking beyond view. For example, people can't observe heat and gravity directly, but indirectly, they can look at the impact of heat on a thermometer.

The emergence of science

Early civilization

Over the millennia, people developed a wide range of skills. Around 1000 BC people developed new skills in agriculture, metallurgy and mining. With this knowledge, abstract concepts were developed. Farmers developed skills to observe the weather, the moon, the sun and other changes. These observations ultimately led to the development of a precise calendar. People also developed knowledge about fertilizers and plant growth and developed mathematical knowledge to measure plots and set boundaries. The **orderliness belief** is the core hypothesis of science: the assumption that the universe works in an orderly way.

Greek science

The origin of empirical science dates to the pre-Socratic Greek period (c. 600 - c. 400 B.C.). Thales (c. 625 - c. 547 B.C.) was the first Greek philosopher to combine empirical and rational insights, and he is also called 'the father of science'. Thales' philosophy rejected mysticism and emphasized the observation of natural events in a natural, orderly universe. His philosophy is known as the **Ionian philosophy**. The views of Thales inspired Hippocrates. Hippocrates (c. 460 - c. 377 B.C.) was a physician who tried to understand illnesses by carefully observing patients and thinking rationally. Later, mystic philosophy was rejected by Ionian philosophy, and the observation of natural events was emphasized in an orderly universe. The important next step was taken by Strato (d.c. 270 B.C.). Strato also was an Ionian. His view was that empirical manipulation and observation (**experimentation**) are the best ways to acquire knowledge. At the time of Strato, however, empirical science fell into decline. After 400 B.C., Greek philosophy became increasingly mystical. It changed the way people watched discoveries. Philosophers began to discuss that the regularity of the number of relationships and the orderliness observed in the astronomy indicated that divine intelligence controlled nature. Earlier, researchers wanted to understand and control nature, but later, philosophers tried to demonstrate divine intelligence through their research into nature. Science began to serve religion; a role that lasted two thousand years.

Medieval science

By the end of the fourth century, Christianity was the Roman state religion. This had a huge social and political influence until a thousand years later. Theology, the study of God and God's relationship with the universe, dominated science. Revelation, rationalism and authority became the most important sources of knowledge. During the twelfth and thirteenth centuries, major changes took place in politics, art, trade and research. People focused more on the world around them. This caused revival of ancient Greek, Greek-Roman and Islamic science.

Although science from the seventeenth century was less of service of religion, Christian constraints imposed two restrictions. First, empirical science should not contradict theological dogma; the truth would still lie within faith. Secondly, science should be used only in the service of faith.

The scientific revolution

In the thirteenth century, science dominated the medical world and scientists recognized that science was in service of humanity. In the thirteenth century science collided tremendously with religion. Thus, Galileo was forced to take back his words about the concept of the earth, rotating around the sun. The **scientific revolution** had begun, but only in the nineteenth century scientists got back the independence they lost to the religion more than 1500 years earlier. In the twentieth century, science had become a social movement. This can be seen, for example, by the countless ways in which scientists communicate, such as internet, radio, television, books, newspapers and magazines.

The goals of science
The main goals of science is to acquire knowledge about the universe to understand natural phenomena. Furthermore, science has the following sub-goals:

- **Description**: scientists identify and observe phenomena and cite their details carefully;
- **Prediction**: prediction involves finding relationships to estimate what happens if one knows what happened to the other factor;
- **Causation**: scientists do not only want to say what will happen (prediction), but also want to know what causes the change;
- **Explanation**: explanation is about understanding how certain factors can change other factors. The information is mainly obtained by studying theories;
- **Application**: application is using the newly acquired knowledge to solve real life problems.

Psychology
The history of psychology
The physiology and philosophy of romanticism, rationalism and empiricism in the nineteenth century caused the emerging of the discipline psychology. The science of psychology is mainly influenced by the theory of evolution. With this concept of **phylogenetic continuity** - the similarities between structure and function between humans and other species - it was said that studying animals can help understanding humanity. This idea was completely contradictory to the religious theory that humans are unique to animals. Ernst Weber and Gustav Fechner were the first researchers to objectively study **psychophysics** - the efficacy of mental capacity.

Structuralism
Wilhelm Wundt (1832-1920) founded the world's first psychological laboratory in 1879 in Leipzig. Wundt studied the structure of consciousness - hence the name of **structuralism** - by asking participants to write their mental experiences while performing different tasks. This method is called **introspection.**

Functionalism
Around the beginning of the twentieth century, the attention shifted from the structure of the mind to its functioning. This is known as **functionalism**. In particular, we looked at practical questions about education, training and education. For example, E. L. Witmer (1867 - 1956) worked with children with mental and emotional disorders. He founded the first psychological clinic.

Psychodynamics
The **psychodynamic** theory looks at the function of complex and often contradictory (often unconscious) internal influences. Thus, the importance of dreams, the continuity of emotional behavior from child to adult and sex as a biological natural drift was studied. The founder of the psychodynamic theory is Sigmund Freud (1856 - 1939).

Gestalt psychology
Gestalt psychology originated in Germany around 1912 and was a reaction to structuralism. The founders believed that the structural attempts to divide consciousness into separate sections was at the expense of the overall experience. According to Gestalt psychologists, a whole was greater than the sum of all loose parts.

Behaviorism
Behaviorism occurred in the United States around 1912. Behaviorists criticized psychology as being subjective and mental. Watson pleaded for the replacement of psychology on consciousness through an objective psychology of observed behavior. Animal studies played an important role in the modern study of behavior.

Behaviorists like Pavlov and Skinner studied animal behavior to understand complex processes such as learning. An application of behavioral principles is **behavioral modification**. Therapists use behavioral modification very often in clinics, hospitals and schools.

Humanistic psychology
Humanist psychology originated in the middle of the twentieth century and, for a short time, humanist psychology was very influential. Humanistic psychologists has its focus on conscious human experiences, creativity, expression, human potential and personal growth.

Cognitive Psychology
The **cognitive psychology** is the study of perception, memory and learning processes. Cognitive psychology grew by studying perceptual processes and verbal learning. Modern cognitive psychology is a part of cognitive science. This science connects the separated research areas psychology, behavioral sciences, computer science, neurophysiology and linguistics to each other.

Women and minorities in psychology
The late nineteenth century and the first twentieth century were exciting years in the rise of the discipline 'Psychology'. As in almost all professions at this time, the subject was led by white men. Women and other minorities were forbidden to enroll for colleges. Nowadays most physicians in psychology are men, but the majority of psychology students are women.

Modern psychology
Prior to 1940, psychiatry dominated the applied health programs and psychoanalysis was the major psychotherapeutic model. The collisions between the universities of psychology disappeared and ideals from other universities were integrated into one ideal. For example, behavioral medicine and health psychology have brought together interventions on behavioral change, drug development and theoretical and cognitive psychology, and reduced the awareness of behaviorism. The collaboration between behavioral psychology and neuroscience is also growing, so scientists with more modern techniques can study the brain.

The behavioral psychology and neuroscience together form the **behavioral neurosciences**. Most psychologists are often not only fan of just one school, but they gain their knowledge from many different psychological theories and research areas. This is known as mainstream psychology. Psychology today is part of one of the seven hub sciences (core science), because it is very influential and other scientific and non-scientific institutions get a lot of knowledge here. The other hub sciences are mathematics, physics, chemistry, earth sciences, medicine and social sciences.

The science of psychology
Science is extremely important in psychology. Although science is important in every field, there are plenty of **pseudo scientists** in psychology. Psychology is the field with the most pseudo scientists.

In the pseudoscience, methods, theories, assumptions and conclusions are given which appear to be scientific but are actually not scientifically proven. One example is the advertising industry. Although pseudo science is convincing, one can recognize learning by asking the following questions:

- Where does the evidence come from?;
- In which form is the evidence reported?;
- Do the scientists have certain interests in the outcome of an investigation?;

Pseudoscience can do harm and it has never really brought solutions to problems. However, the scientific study of psychological phenomena has shown that people's impressions aren't always true. Secondly, solutions are encountered, including better teaching methods, more effective treatments, and better ways to solve social problems. As a consequence of developments within science, a clear separation between pseudoscience and evidence-based science has emerged.

Ethical principles
Research, developments and application of research results are currently the most important contributions in science. Science can bring a lot of positive progress. However, people can use science for the wrong reasons, such as glorification of the researcher, acquiring profit for a company or for political purposes. These motivations also cause distorted results. Ethical guidelines have been developed as guidelines for researchers to indicate which processes in the research can cause difficulties. First, every scientist must carefully think about how he or she can contribute best to science and to human prosperity. Secondly, it is the personal responsibility of the scientist to conduct research in an ethical way. This personal responsibility consists of protecting research participants and a fair and accurate conducting and reporting research.

B. The scientific process

Principles of science
All scientific disciplines share the same basic assumptions about nature, namely that:

- A physical universe exists;
- There is arbitrariness and thus unpredictability in the universe, but it is generally an orderly system;
- To discover principles of the orderly universe, carrying out scientific research can be useful;
- Knowledge of the universe is always incomplete. New knowledge changes current ideas and theories. As a result, theories and knowledge are always preliminary.

Observation and conclusion: facts and constructions
Scientific research involves at least the following:

- Asking questions;
- Developing techniques to answer questions;
- Planning and making appropriate empirical observations;
- Interpreting rationally empirical observations;
- Using these interpretations to predict other events.

Empirical observations are referred to as **data** - these are the facts of the research. Facts are the events that can be observed directly and repeatedly. Behavior is the most observed fact in psychology. Observation is the empirical process of using senses to recognize and store facts. **Inference** is an intellectual process in which conclusions are drawn from observed facts or other ideas. Constructs are derived events such as gravity, electricity, intelligence, memory and fear. These are all rational ideas devised by the researcher. Some people use a construct so often that they see it as a fact instead of a theory. Confusing a fact with a construct is a common mistake known as **'reification of a construct'**. There are even more common problems that scientists need to recognize and try to avoid. Here is a list of common mistakes.

- **Nominal fallacy:** this error is made by referring to the designation of a phenomenon as the explanation for a phenomenon;
- **All-or-none bias:** this tends to point out a statement as correct or incorrect, whereas in theory a statement is often a probability;
- **Equal-unique paradox (similarity-uniqueness paradox):** this tends to label two things as true or unique, while in reality it is often both;
- **Barnum Statement:** this effect is named after P.T. Barnum, who would have stated the following statement: 'there is a sucker born every minute'. Here, a reference is made to making a statement that seems insightful, but in reality can almost be applied in any situation.
- **Evaluative biases of language:** science should not be biased, but language often adds subtle judgments to objective behavior.

Inductive and deductive reasoning
By **inductive reasoning**, one argues based on specific evidence that builds up a whole model or theory. During **deductive reasoning**, more abstract and general ideas are used in order to make predictions about future hypotheses. Scientists use both inductive and deductive reasoning during research: theories are developed by means of inductive logic, whereas predictions are derived from deductive logic and are empirically tested.

Models and theories in science
One of the researcher's main task is the development of theories. A **theory** is a formalized set of concepts, which summarizes and organizes observations. In addition, a theory provides preliminary explanations of certain phenomena and is the starting point for formulating predictions. However, a theory can only be useful during scientific research when the hypothesis is testable: the hypothesis should be specific enough for

testing empirically. In addition, a good theory must be falsifiable. This means that it is possible, by empirical experimentation, to prove the statement to be wrong.

A **parsimonious theory** is relatively uncomplicated and should be used when the predictions are equally accurate compared to a more complex theory. A good theory must be valid, meaning that there are specific and testable predictions that can be confirmed by observation. Also, when evaluating a theory, we look at the **usefulness** of a theory. A theory is useful if practical problems can be solved. Theories that emphasize induction are called **inductive theories.** These theories always remain close to the empirical data. B.F. Skinner introduced inductive theories. With these inductive theories he formed hypotheses about different circumstances, in which reinforcement plays a role. He did not speculate about processes that can't be seen, such as thoughts and feelings. These non-visible processes are called **intervening variables**.

The more traditional theory, however, is the deductive theory, which emphasizes on the deduction of constructs. These deductions are hypotheses that scientists empirically test by conducting research. Most psychological theories are functional theories, which focuses about as much on induction as on deduction. Inductive, deductive and functional theories all aim at organizing knowledge, predicting new observations and explaining relationships between events. A fourth type of theory is a **model**. Each phenomenon can be presented as a model. The word is derived from 'modulus' – a Latin word which means 'small amount of something'. Models are less advanced than theories, therefore these models are also called 'mini theories'. A model represents reality and does not copy reality. The better a model represents reality, the more useful the model is. All models share the following features:

- Models are simple representations of a phenomenon and closely match some features of the phenomenon;
- Models provide a compact representation of a larger, more complex and often unknown reality;
- Models are incomplete, provisional and analogous to the phenomenon;
- Models help researchers organize information, indicate relationships between certain parts, create new ideas, and predict new observations.

The phases of experimentation

Psychological research begins with an idea and then usually occurs in a number of experimentation phases:

1. The **idea-generating phase**: identifying a topic or interest to study;
2. The **problem-definition phase**: Refine the general idea to a specific question. This question is formulated by acquiring knowledge of existing literature and by its own ideas and speculations.
3. The **procedure design phase**: the variables must be defined and the procedures, such as the participants and the observation method, must be selected. It's important to take ethical issues into account.
4. **Observation phase**: this phase is central to all sorts of scientific studies. The earlier phases were aimed at planning the study and the final stages focused on the interpretation and communication of the obtained results. However, during the observation phase the research will be conducted and the question will be answered.
5. The **data-analysis phase**: the data obtained are analyzed using appropriate statistical methods. The statistical technique used depends on the research question and the nature of the data.
6. The **interpretation phase**: first, the statistical findings are interpreted by answering the research question. Secondly, it is examined how the findings relate to the research question, and thirdly, it is examined whether there are alternative interpretations of the data. In addition, the theory can be modified based on current findings.

7. The **communication phase**: At this stage, the findings are presented by a written or oral report of the study, with all the steps detailed accurately described. It is important for researchers to specifically describe their research process, so it is possible that other researchers can reproduce the experiment as in the original study. This is called **replication**.

Levels of limitation
The first dimension of the research model consists of the phases of research that have just been discussed. The **levels of constraint** constitute the second dimension of the research model. This implies the extent to which the researcher is bound by limits or controls at every stage of the research process. The phases of research and the levels of constraints together form a two-dimensional model of research. There is a summary of levels of limitation, starting with the lowest level of limitation, and ending with the highest level of limitation. However, the levels of limitation are not strictly separated from each other: they form categories in a continuum that overlap with each other.

- **Naturalistic observation**: The researcher observes the behavior of participants in their natural environment without affecting their behavior and without manipulating their environment. The only imposed restriction is the used observation method. This sort of observation is often used at the beginning of conducting the study and is useful in formulating hypotheses.
- **Case study research**: during this type of research, the researcher may intervene in the functioning of the participants by asking questions, for example. Although the limitation in this study is slightly greater than in a naturalistic observation, there is still much freedom to shift attention to the relevant behavior. Studying a single individual is typical of a case study.
- **Correlational research**: In this study, the limitations of measuring behavior are a lot worse. The setting can vary from the setting of a naturalistic research to the very limited setting of a laboratory. Because of the relationship between two or more variables, the procedures must remain consistent during the measurements.
- **Differential research**: This research involves two or more groups of participants. The groups are determined based on preexisting variables, which are the same among the participants. Interpreting group differences requires skill, knowledge and caution.
- **Experimental research**: Participants are randomly assigned to the conditions and divided into groups. The distribution of participants into groups often happens blind and in this way the differences between groups are attributable to the influence of the condition. In experimental methods all aspects of the research are planned in advance and the procedures are followed exactly as planned. Because all steps during the research is planned prior to the experimentation phase, experimental research is limited. However, it is the best way to test causality.

Different levels of restriction
Research always starts with few restrictions. Subsequently, conclusions from these studies with little restriction are used for conducting research with more restrictions. This is one of the biggest goals of doing research with few restrictions. As the research shifts from a low to a high level of restriction, the procedures and experiences are increasingly more strict and more precise. Unfortunately, there is also a risk that the procedures will become increasingly unnatural, so that the experimental setting imitates less accurately the real world, and therefore the results are also less relevant. To solve this precision versus relevance problem, scientists should conduct research at the highest level of restriction and test the results in natural conditions.

Ethical principles
In the procedure design phase of the study, choices are made regarding the participants. Participants are subject to research based on allocation to the conditions. Because of the use of living organisms, the researchers are responsible for the safety and well-being of these participants. The proposed research plan must be approved by the Ethics Committee in the design phase, before continuing to the next phase.
If there are ethical problems, the researcher must first adjust the plan before resuming research.

The **American Psychological Association (APA)** was one of the first organizations to establish ethical guidelines. According to the APA, the following ethical principles of psychologists are the most important to pursue:

- Psychologists strive to care for those with whom they work and do not harm them;
- Psychologists establish a relationship of trust with those with whom they work;
- Psychologists strive for accuracy, honesty and truth in science and in teaching and conducting psychological research;
- Psychologists recognize that everyone has equal access to and benefits from psychological activities;
- Psychologists respect the value of all people, including people's privacy.

C. Asking questions as a starting point

Following up the work of others
With theoretical research, new questions are raised for further research. Formulating questions occurs in two ways: 1) by heuristic and 2) by systematic influences. **Heuristics** occur when interest is raised with theories or research results, including disbelief or absolute antagonism, and further research questions are suggested. **Systematic influences** occur when there are suggestions for further research.

Applied, basic and translational research
Applied psychology is the search for solutions to certain problems. Much research in psychology is therefore applied research. With applied research, the main question always tries to collect data in order to solve a current problem. Questions in applied research are therefore solution oriented. **Basic research** - also known as **fundamental research** or **pure research** - aims to improve scientific insight, without specific practical purposes. Scientists often use basic research as a fundament for applied research. For example, one can do basic research on language development in children, and then apply the knowledge to develop programs to reduce language problems. This combination of basic research and applied research is called **translational research**.

Refine research questions
Research begins with the gradual refinement of the research question. To formulate the key question is very important because it determines how the research will be conducted. Once the main question is asked, the choices for the restriction level, the observation method and the choice for the type of statistical test will follow automatically.

Type of variables in research
A variable is any set of events or data that can have different values. For example, gender is a variable because there are two different types of gender and behavior is variable because there is a large variety of different behaviors. Variables are divided into three types:

- **Behavioral variables**: Each observable and immediately perceived response of an organism is a behavioral variable. Psychology is the study of behavior and therefore behavioral variables are most observed in research. These range from simple tasks, such as the push of a button, to more complex processes, such as social and verbal behavior.
- **Stimulus variables**: behavior always occurs in a surrounding context. Stimulus variables are all variables that may affect the behavior of the subject. Stimulus variables are often very specific and easy to check or measure. One example is a loud noise in a research room.
- **Organic variables**: organic variables are also called **subject variables**. Organic variables are characteristics of the participants, such as age, gender and hair color. Organic variables are gathered under **observed organic variables** - characteristics that are immediately noticeable - and **response-derived organic variables:** characteristics that are not immediately perceptible, such as sexual preference. Response-derived organic variables are also called constructs.

Classifying variables based on research
In addition to distinguishing variables based on their characteristics, a distinction can also be made in variables that are constructed for use in research: **independent variables** and **dependent variables**. The variables that the researcher manipulates are the independent variables. The participants' reaction to these manipulations are dependent variables. Independent variables distinguish between two types: **non-manipulated independent variables** and **manipulated independent variables**. Manipulated independent variables are variables that are actively checked by the researcher, such as rewards based on personal preferences.

Non-manipulated independent variables - also called **classification variables** - are divided into groups based on existing features, such as age and IQ. Researchers often formulate hypotheses about a causal relationship between the independent and dependent variables. A **causal relationship** between two variables exists if a change in one variable results in a predicted change in the other variable. However, it is very difficult to draw causal conclusions without manipulating the independent variables. To this end, drawn conclusions on a causal relationship in a study with non-manipulated independent variables should always be under caution.

Extraneous variables are unplanned and uncontrolled factors that arise during experimentation and affect the outcome. Therefore, researchers need to check extraneous variables to prevent their possible effects. They do this by taking as many precautionary measures as possible. An example of an extraneous variable is taking an exam in a noisy environment. In this case, the interfering variable can be checked by taking the exam in a quiet environment.

Variables and constants
Scientific research is all about studying events. If the events vary, these are called variables. If researchers restrict events so that the events do not vary, then they are **constants**. Constants are thus a set of events in which the researcher prevents them from changing.

Validity and control of interfering variables
Validity is one of the most important concepts in scientific research. There are many types of validity. In general, all types of validity refer to the quality or precision of an investigation, procedure or method of measurement to show how well the subject is studied as it should be studied. A fundamental purpose of research is to optimize validity by applying appropriate controls. **Controls** are the procedures used to limit interfering influences in research. Controls are most important in high-level research, but are part of research at all levels.

Ethical principles for human research
Ethical principles emphasize the fact that researchers must protect their participants against deception, dangerous procedures and privacy violations. The ethical principles are written in the Belmont Report.

According to the **Belmont Report** ethical research with people should meet the following three key principles:

- **Beneficence**: the risk for participants must be as small as possible and the benefits to participants and society should be as high as possible. In addition, any risk to the participants must be weighted against the possible benefits.
- **Autonomy**: Participants must get enough information to decide whether they would like to participate in the study.
- **Justice**: the risks and benefits due to the study should be distributed equally across all participants in society.

Deception or **concealment** involves deliberate misleading of participants by giving false information (*deception*) or by not providing information (*concealment*). Although the use of deception has grown over the years, it has become more innocent. Deception, however, involves risks for the participants. Therefore, researchers need to take security measures to minimize the effects of deception. The two most common safety measures are (1) the researchers' opinion that deception does not cause serious long-term risks, and (2) explains the reason for deception in a discussion with participants immediately after the experiment (*debriefing*). This must solve discomfort and misconceptions, possibly caused by deception. Another key safety measure is **informed consent**. This means that researchers must provide enough information to participants so that participants can make informed decisions about their participation.

Infringement of privacy may arise when investigating personal subjects, such as sexual behavior, personal emotions and thoughts. Researchers are therefore obliged to keep information confidential: they have a **confidentiality obligation**.

While research can be very good for society, participants can also face risky situations. As an attempt to solve this dilemma, research agencies, universities and professional organizations have adopted the following:

- Scientific research should provide potential benefits to society;
- It is reasonable to expect people to behave in a socially responsible way and contribute to knowledge by participating in research;
- Participants have basic rights when they are selected to participate in research. This also includes the right to privacy and protection of physical and psychological damage;
- Researchers are required to provide sufficient information about the study. Participants can decide on whether they want to participate;
- It is the responsibility of the researcher to respect the rights of participants and to protect them against potential damage.

Institutional Review Boards (IRBs), also called an **institutional review committee**, consist of researchers, colleagues and members of the general community. Universities, research institutes, hospitals and school systems target IRBs to review research proposals and see if they comply with ethical guidelines. Any organization receiving federal funding is obliged to have an IRB. A well-functioning IRB is a useful advisory group that supports research, advises researchers, suggests improvements, and guides researchers in following ethical guidelines. However, financial ethical responsibility always lies with the researcher himself. Researchers must assess their research in terms of the value to science and the risk that it represents for the participants.
In addition, they must assess whether potential benefits exceed potential risks and whether security measures have been taken to reduce the risks. This procedure is called a **risk-benefit analysis**.

Ethical checks are made on a preliminary draft. The following questions are discussed:

- Does the research have an informative value?
- Are there any physical or psychological risks that could damage participants in the event of a deception, are sensitive subjects discussed or are minors or other participants used who can't give their consent?
- If this is the case, have enough controls been built to prevent this danger?
- Has the informed consent been signed?
- Did the participants receive good feedback at the end of the study, including a debriefing if deception has been used?
- Does the researcher take his or her full responsibility for the ethical and safe treatment of all participants?
- Should relevant ethical research committees have approved this study?
- Are all animal safety measures taken if animals have been used in the investigation?

Ethics and diverse research issues
Diversity refers to the extent to which the research sample is a reflection of different ages, races, cultures and gender. If this is not the case, a scientific study can only be done about the groups tested and no general statement can be made in response to the investigation.

Ethical principles for animal research
Ethical guidelines for animals are as important as the guidelines for humans. The ethical guidelines for animals concern the selection of animals, in an appropriate and human way of relocation and concern preoperative and postoperative care. In addition, it is noted that the possible pain and inconvenience are minimal. In the USA, all laboratories receiving federal support must be in charge of a laboratory animal care committee. This is the same as the IRBs for people.

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