Research methods in psychology

1. Content and aims

In psychology, large variety of research methods are applied, all of which are differing in several respects. Researchers have the responsibility to choose a method which serves best the purpose of the study, suits the studied construct and the investigated subjects available, and eventually reflects the applied psychological approach. The decision must be cautious and scientifically confirmed, as all methods imply not only advantages, but limitations and downfalls.

The aim of this course is to establish, enrich and encourage scientific thinking regarding psychological studies, and psychological problems. Students completed the course must be able to analyze psychological research in terms of research method, variables, design and identify the corresponding special advantages and disadvantages. The course enables students to plan research studies in a scientifically established manner regarding conceptualization and operational planning in detail. A special emphasis is made on experimental research, namely on planning of experiments, experimental designs and special problems of experimental studies. In general, the course develops critical thinking regarding research.

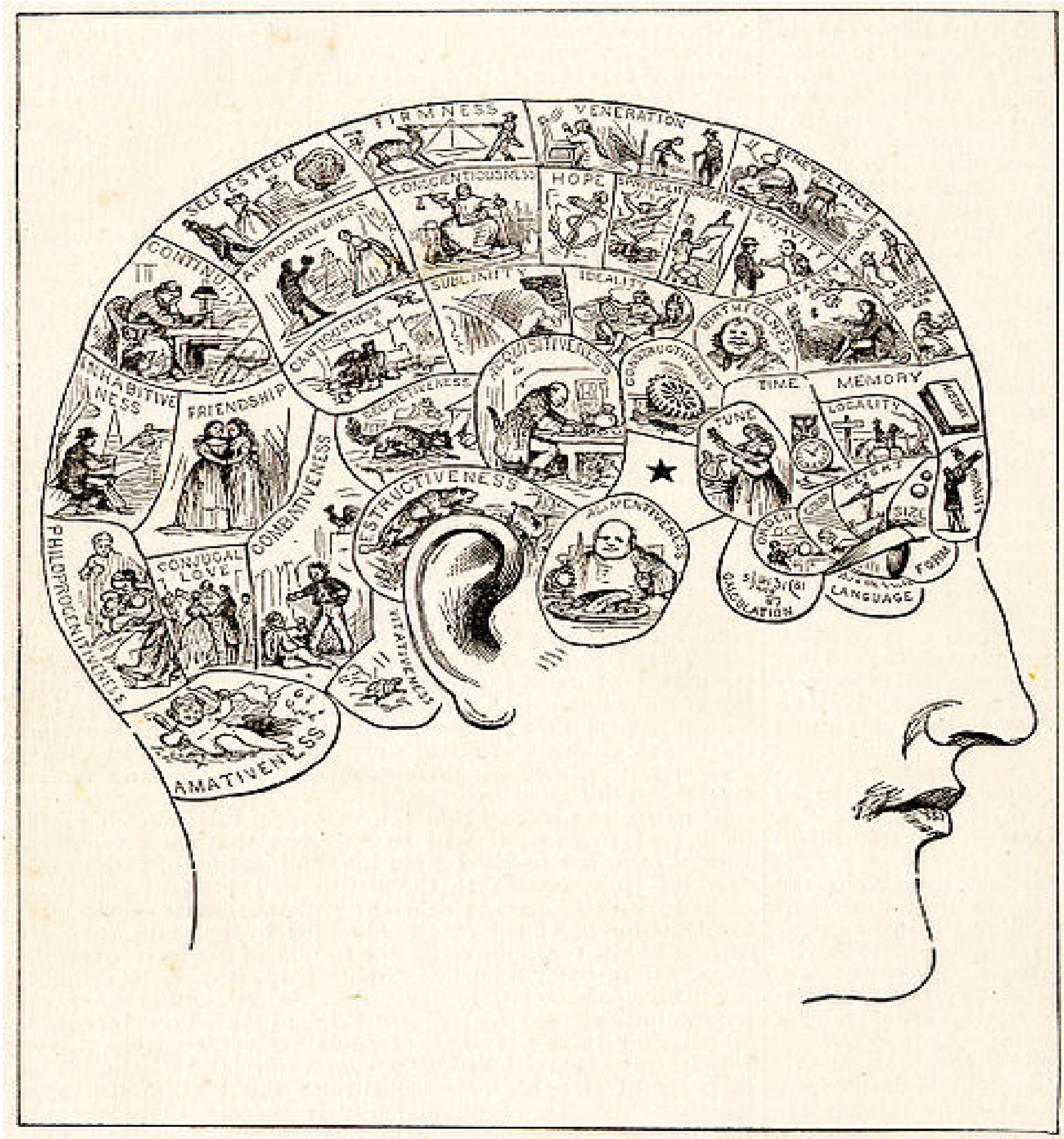
Course activity includes collective discussion; analyzing several hypothetical and historical psychological experiments; and research activities. The course book is C. James Goodwin (2005). Research in psychology (Fourth edition). Hoboken, NY: Wiley. Supplemental materials as tests and exercises are applied with the formal permission of WileyEurope Higher Education.

2. Scientific approach to psychology

Scientific psychology is lead by the belief that human behavior has underlying rules which can be discovered through scientific methods, thus can be predicted. These assumptions of the scientific approach to psychology are termed *(statistical) determinism* and discoverability, respectively. Based on this basic logic, *empirical questions* are formulated, corresponding studies are planed, and *data-based conclusions* are drawn.

The third major feature of the scientific approach is objectivity, which enables different researchers to derive the same conclusion from the same study. Furthermore, in order to provide all necessary information for study replication, precise and detailed research descriptions are required.

The basic difference between science and *pseudoscience* is that in the former, unlike in the latter, every conclusion without solid empirical support is questioned. The more difficult is to make a distinction of the two, the more important is to do so, in order to avoid investing in research based on former false conclusions. An interesting example for a pseudoscientific stream from the history of psychology is phrenology. Phrenology had the aim to locate personality within the skull (Gall, 1938; see Figure 1). The first important representative of this stream was Gall in the early 19th century. Phrenologists believed that touching, feeling bumps on the skull helps defining the personality of a subject, as they indicate emphatic characteristics. Of course, the doctrines of phrenologist were disproved (e.g., Flourens, 1846).



Phrenological Chart of the Faculties.

Figure 1
Skull with the locations of faculties proposed by phrenology, as an example for pseudoscience (Wikipedia, 2009a)

The goal of scientific psychology is to *describe behavior* properly in detail, *provide explanation* for human behavior in various settings, *formulate general laws*, *establish prediction*, and *support behavioral change*. In order to have an example of a researcher who is considered to clearly meet the requirements of scientific research, consider B. F. Skinner (see Figure 2). His scientific work on operant conditioning was the first step of experimental psychology (e.g., Skinner, 1935).

Related reading: Chapter one in the course book.

Figure 2
A scientific skull, B. F. Skinner (Wikipedia, 2009b)

3. Research planning

3.1. Research types

Psychological research can be classified in numerous ways, for example based on the goals, the setting, and the applied methods.

Research can be fundamental or applied. *Fundamental research* aims to discover, describe and understand elemental features of behavior. Traditionally, fundamental studies focus on, for example, different aspects of perception, memory and learning. *Applied research* deals with more specific, practical problems, in real-life context. However the two are closely related. The basic findings of fundamental research can be used in various situations and applied research results can reflect on fundamental issues.

Both applied and fundamental research can be carried out in laboratory or in a field setting. However, fundamental research is mostly carried out in laboratory settings, and applied research is carried out in field settings. *In laboratory*, the researcher has a closer control on every aspect of the study; on the other hand, *field research* provides more realistic models to real-life situations. Laboratory experiments, may not have such proximity to life as field research has, but led to important discoveries and give a solid basis for scientific requirements for field research. Field research, beyond searching for solutions to practical problems, is also used to test laboratory experiment results in real-life situations. Sometimes the real circumstances simply cannot be correctly modeled in a laboratory. Moreover, the combination of the two is also occurs, and rather fruitful.

Beyond fundamental and applied, laboratory and field research, quantitative and qualitative research methods are differentiated. *Quantitative research* collects numerical data subjected to statistical analyses; its main types include experimental and correlational research. *Qualitative analysis* stands for a more comprehensive, realistic approach and usually the obtained data is summarized as an analytical narrative. Observational research is an example for qualitative analysis. Qualitative analysis often involves face to face interviews, focus groups, or case studies, which cannot be summarize easily in a numerical way, but can provide a deeper understanding of the investigated issue.

All research types will be further described in detail, with a special emphasis on experimental research. Experimental research is accentuated, especially because the close control on the situation enables the researchers to draw strong conclusions from the results of experiments, even causal conclusions.

3.2. Developing research

Research ideas often come from everyday observations, or problems occurring in unusual situations. Accidental findings can lead to research, which achievement is known as serendipity. On the other hand, wide variety of literature is available on psychological theories that organize and summarize existing knowledge. Therefore literature and theories provide a good basis for creative associations, innovative thoughts. When research ideas are deduced from theory, the results can support or disprove existing theories. Finally, new studies can be arisen from earlier research findings.

Thinking scientifically, research ideas must lead to empirical questions. Empirical questions have two important requirements:

1. empirical data, which can be collected, must answer the question.
2. empirical question and the involved terms must be precisely, *operationally defined.*

Operationism was a stream in physics in the early 20th, the members agreed that scientific terms must be objective and precise. Therefore all concepts must be clearly described as operations to conduct. The main concept of operationism can be implemented also in psychology: general research ideas should be narrowed to concrete specific questions in settings, concepts must be translated into measures. And all important factor of the setting, method, registered variables and levels of variables must be operationally defined.

Related reading: Chapter three in the course book.

4. Measurement and data analysis

As noted earlier, the first steps of research planning must involve the deliberate definition of selected measures. All concepts must be translated into measures. In this section, related to this step, measurement scales, evaluation of measures and data analysis will be discussed. It is important to note, that research planning must deal not only with the selection of measurements, but also with planning of data analysis. However, within the frame of this course data analysis will not be discussed in great detail.

4.1. Measures, measurement scales

The *operational definition* of the measured concepts is required. The concepts should be precisely, unambiguously defined and translated into applicable measures.

Statistical analysis of the obtained data enables us to make justifiable conclusions. The type of collected data is essential to the selection of the valid statistical procedures. Four *measurement scales* are differentiated: nominal, ordinal, interval, and ratio scales. There are three features of numbers which make the distinction of the four measurement scales: ordinality, cumulativity, and rationality of multiplication. A comparative table is provided in Table 1.

Table 1.
Features of measurement scales

Nominal	Ordinal	Interval	Ratio
The same scale value represents the same category	Ordinality: Higher scale value represents more from the same attitude, concept, or behavior.	Ordinality Cumulativity: The difference between a scale value and the former value or the later value is equal.	Ordinality Cumulativity Rational of multiplication: Ratios of consecutive scale values are equivalent
The scale values do not have numeric meaning.	Differences between adjacent scale values are not constant.	Ratios of consecutive scale values are not equivalent	There is an obvious zero point fro the scale

Nominal scale value does not have any of the above mentioned features of numbers; the different levels of the variable represent distinct categories. Gender; marital status; extrovert or introvert distinction of personality; treatment type with categories: control group, medical treatment, training group are examples of nominal scale variables.

Ordinal scale variable values have a definite order, but the differences of the scale values are ambiguous. Ranking values are ordinal scale variables: attractiveness (expressed by ranking) of different holiday possibilities; rank order of student's talent in music provided by the music teacher and so on. But not only rankings, but other kinds of variables also have ordinal scale, such as qualification expressed as low, medium and high qualification; or alcohol consumption habits with categories: never, rarely, sometimes, often, always.

Interval scale measurements have the features of ordinality and cumulativity. This measurement scale is in excess of the ordinal scale, in the sense that difference between the scale values is meaningful and constant. Most personality scores have interval scale, a typical example is the IQ measured by the Wechsler test.

Ratio scale variables have all features of numbers that is also the ratio of the scale values is meaningful and constant. An important additional feature is the presence of an obvious zero point for the scale. Ratio scale measurements are for example the reaction time, body temperature, mostly physical measures.

Traditionally, interval and ratio scale measures are preferred as they easily can be analyzed in various ways, given the wide variety of the available statistical procedures. Nowadays, analyzing nominal or ordinal data is not a problem, but the researchers still intend to obtain ratio or interval data if possible.

Categories as *quantitative and qualitative measures* are also used in practice. Nominal and ordinal scale measures are rather qualitative, although ordinal scale variables with fine calibration can be considered as quantitative measures, together with interval and ratio measurements. *Discrete and continuous measures* are also differentiated. Discrete is a measure which has limited number of values (nominal and ordinal scale), while continuous a measure which has unlimited number of measures (interval and ratio scale).

4.2. Reliability and validity

Reliability and validity can be understood in respect to measures and to research procedures. Here, these terms in respect to measures will be clarified. Useful measures in psychology must have a degree of both reliability and validity. Reliability guarantees an acceptable level of measurement error, while validity indicates that the measure assess the concept it is supposed to assess. A valid measurement implies a certain degree of reliability, but not vice versa. In real life situations, since these concepts evaluate the applied measures, they have ethical implications. If an applied measurement tool does not fulfill the requirements of reliability and validity, the conclusions about people's life (e.g., selection, dismissal, need for treatment) are not correct, and makes the whole procedure unfair.

4.2.1. Reliability

A measure is reliable if the obtained results are repeatable. Reliability is a reverse function of measurement error. Reaction time is a typical example for a highly reliable measure. Reliability is high if reaction time is automatically registered, as for example by a computer, but, of course, it can decrease if human factor is involved, think for example of a stopwatch of a very old researcher. Reliability is often measured in case of psychological tests, simply by correlational measures.

4.2.2. Validity

Validity means that a measurement instrument must measure truly the concept it is required to measure, and not any other concept. A measure has face validity if it seems to make sense to use. However, it does not make a valid measure by itself. A more profound criterion of validity is criterion validity, which requires the measure to give similar results as other measures of the same concept (1) and to provide reasonably good predictions for the future (2). A third type of validity criterion is construct validity, meaning that the applied measure measures the desired phenomenon, and at the same time, this is the best measure to be taken.

4.3. Data analysis

Important to note that mostly the data is a *sample* from the *population*. Therefore, the descriptive statistics summarize the features of the sample and inferential statistics allow the researcher to draw conclusions about the population, based on the sample.

The data can be represented using *descriptive statistics*: central tendency, variability. When the sample is summarized, several *visual techniques* can be used as well. Depending on the scale of measurement, different methods are applied. Some of the applicable methods are indicated in Table 2.

Table 2. Some of the applicable visualization techniques and descriptive statistics for the measurement scales			
Nominal	Ordinal	Interval	Ratio
Pie diagram Mode	Bar chart Mode Median Range	Bar chart with intervals on the x-axes Mode Median Mean Range Interquartile range Variance	Histogram Mode Median Mean Range Interquartile range Variance

Inferential statistics are used to describe tendencies beyond the effect of chance. In hypothesis testing, inferential statistics answer concrete statements, usually about the effect of some variable, the relationship of variables or the equality of some measures. Conservative, null hypothesis (H0) states that there is no connection, groups are equal. Alternative hypothesis (H1) states otherwise. It is important to note that statistical hypothesis and research hypothesis are not the same, mostly the research hypothesis agrees with H1. The concrete statistical analyses must be selected based on the investigated hypothesis and the measurement scale of variables. Although the selection of the proper statistical procedures is not dealt with in detail within the frame of the course, general rules of hypothesis testing will be reviewed.

Table 3. Statistical conclusion		
	Reality	
Decision	H0 true	H0 false
H0 accepted	Correct acceptance	Type II error
H0 rejected	Type I error	Correct rejection

In Table 3, possible outcomes of the truth and decision about H0 and H1 are shown. Naturally, *hypothesis testing* must reduce Type I and Type II error rates. The probability of rejecting H0, although it is true (Type I error) is set by α criterion. α mostly have a value of 0.05, but a more strict criterion, that is a smaller value, can also be used. The other type of mistake regarding the conclusion is Type II error, when although H0 is false, the researcher fails to reject it. Type II error can be caused by measures not sensitive or not reliable enough.

There are special, important measures in connection with inferential statistics, which must be outlined. *Effect size* provides an estimate of the magnitude of the proven differences, effects. *Confidence intervals* show the range in which the calculated statistic located with a high confidence, for example 95% of the cases. Finally *power* of a test shows the possibility of correct rejection.

Related reading: Chapter four in the course book.

5. Experimental research planning

Experimental research is a type of quantitative research where the researcher has a great control over the circumstances and the research setting. Therefore, the information provided by experimental studies is especially valuable. The research plan has a great responsibility to provide the proper control and must be well-overthought.

5.1. Variable types in experimental research

From the time the famous Experimental psychology of Woodworth (1938) was published, experimental research was considered a scientific method of manipulation. In an experiment, all conditions are held constant, except for the *independent variable* which effect is investigated on the *dependent variable*. The values of the manipulated independent variable are often different situations, tasks or instructions for different research participants. The term dependent variable denotes the operationally defined, observed behavior. All other factors are called extraneous variables which need to be carefully controlled, in order not to interact with the investigated variables.

5.2. Validity of experiments

In connection with experimental research, the fourfold meaning of validity is discussed below. A valid experiment requires a precise and meaningful definition of dependent and independent variables (construct validity); the lack of confounding variables (internal validity); correct use of statistics and careful conclusions from the obtained results (statistical conclusion validity); and the confidently wide limits of generalization (external validity).

Construct validity requires a rigorous operational definition of the variables, concepts that are used. *Internal validity* implies a strong confidence of the researcher that the obtained results are due to the manipulated variable and not the consequence of any other factor. *Statistical conclusion validity* can be violated in several ways: the researcher may choose a wrong type of analysis for the given purpose; ignore data requirements for the used statistical analysis; report only a prosperous part of the results; draw false, unproven conclusions. *External validity* tells us about the degree to which the results can be generalized beyond the population, environment and historical time which was present in the research. Ever so important external validity is, usually the external validity of a result develops over experiments regarding the same issue involving different people, settings, and time. Therefore, external validity should be noted, but during the process of designing an experiment, it gets a smaller weight.

5.3. Control problems in experimental research

While discussing control problems in experimental research, beyond the general problems of bias, problems of between subject and within subject designs should be differentiated. In a between subject design, the different values of the independent variables occur in case of different groups of participants. In a within subject design, the different values of the independent variable occur in case of the same subject. Both situations lead to special problems.

5.3.1. Control problems in between subject design

In a study with a between subject design, the groups are selected to differ in terms of the independent variable, but be equal in every other respect. In case of a large sample size, random assignment can fulfill this requirement. *Random assignment* means that every participant has an equal chance to be a member of any of the groups. It should be noted that random selection is not equivalent with random assignment. After a random selection, placing the participants to groups involves a random assignment. Random assignment can easily lead to unequal groups, because nothing ensures that the only difference among the groups is the value of the independent variable.

Block randomization ensures an equal number of participants per group. More precisely, block randomization means that a member of each group is selected in each round of the randomization, before a second member is selected to the same group. The following steps must be carried out:

1. Decide the number of conditions, the sample size and the sample size per condition. For example, three conditions, a sample size of 90, that is, 30 must be the sample size per condition, if equal number of participants per condition is preferred.
2. Designate the different conditions with numbers. Given the example, 1-3 are the numbers.
3. Take a table with random numbers, following the rows, select numbers 1-3, do not select any number the second time, before you select each in a block once. A possible outcome for the first numbers (blocks are separated with semicolon):
   1,3,2; 2,1,3;2,1,3;2,3,1;3,2,1;1,2,3; and so on, till 90 numbers are collected.
4. Participants, in the order they volunteer to the experiment, are assigned to the experimental conditions one after the other following the master sheet, created in step 3.

Small sample size or the presence of an obvious confound calls rather for *matching procedures*. Matching requires a preliminary testing (by a reliable and valid test) on the matching variable, and depending on the number of conditions, pairs, triplets or larger groups are formed with similar values on the matching variable. The group members randomly assigned to the experimental conditions and the experiment only can take place after all participants are assigned to the groups. The testing on the matching variable may require an extra occasion and can cause logistical problems. Furthermore, often it is not easy to decide which are the possible confounds and how many matching variable must be used. Therefore, if possible, a large sample size should be used, in order to avoid the special problems of matching.

5.3.2. Control problems in within subject design

In a study with a within subject design, each participant is tested on each condition, hence this design is also called a repeated measure design. A within-subject design is economic, as many observations derive from a small number of participants. Therefore, it is a good choice when the number of available participants is small (when the population is small). Another advantage is that the within-subject design eliminates the problems stemming from nonequivalent groups.

However, the force for repetition raises the demand for control on sequence or order effect, progressive and carryover effect. *Sequence effect* refers to the effect of an earlier completed condition on the performance of a later condition, normally this effect expressed in improvement in the performance. On the contrary, *progressive effect* means the effect of repeated trials, and it normally associated with declining performance. The direction of the *carryover effect* is not that evident. It simply means that the experience of the former trial (condition) affect the performance in the following trial(s). The reason can be the effect of the results on the self-esteem: some tasks encourage, while others discourage the participants.

Control on the different effects stemming from within subject design can be provided by applying more sequences (every condition is repeated per person) or partial, complete counterbalancing when the subjects complete the tasks only once.

5.3.2.1.Participants complete every condition once

When *complete counterbalancing* is applied, every sequence of the conditions is used at least once, therefore the minimally needed sample size is X!, where X denotes the number of conditions. For example in case of five conditions 5!=5x4x3x2x1=120 participants are required. Obviously, complete counterbalancing requires many participants when the number of conditions is large.

Partial counterbalancing can be obtained in at least two ways: a random sampling from the population of sequences, or using a Latin square. Random sampling from the possible sequences clearly does not lead to a well balanced setting when the sample size is far from X!.

However, the balanced Latin square ensures that every condition takes an order position only once and every condition comes before and after every other condition only once. The name of the design comes from an ancient Roman puzzle where letters must have been placed taking into account similar criterions. How a Latin square is constructed? Following the steps below, as an example a study with six conditions is considered.

1. Construct the first row! A refers to the first condition of the experiment, and 'X' refers to the last condition of the experiment. The first row is A B X C X-1 D X-2 and so on. If six conditions are used, the first row is: A B F C E D.
2. Construct the second row! Every letter in the second row is the following letter in the alphabet of the one in the first row (in the same position). The only exception is in the first letter in the second row under the last letter in the first row. The general form is B C A D X E X-1 and so on. If five conditions are used, the second row is: B C A D F E.
3. Construct the remaining rows in a way, that at the end a square is obtained, that is the number of rows and columns are equal. Given the six conditions a 6x6 square is obtained:
   A B F C E D
   B C A D F E
   C D B E A F
   D E C F B A
   E F D A C B
   F A E B D C
4. Finally, the conditions of the study are randomly assigned to the letters.

Latin square is always used following the above described steps when the number of conditions is even, however, a second square is needed, when the number of conditions is odd. The second square is the complete reverse of the first square. Furthermore, when a Latin square is used, the minimal sample size must equal the number of rows and the sample size must be a multiple of the number of rows.

5.3.2.2. Participants complete each condition more than once

When the subjects can complete the tasks more than once, reverse counterbalancing or block randomization can be used. *Reverse counterbalancing* means that the different conditions are presented in an order and after that a reverse order is used. Consider an experiment with five conditions, A B C D E E D C B A is a possible design. If needed, the two orders can be repeated several times. A B C D E E D C B A A B C D E E D C B A is one such design.

However, reverse counterbalancing, especially if the conditions repeated several times, enables the participants to predict the subsequent condition. *Block randomization* eliminates this problem. Block randomization can be used for defining an order of the conditions, similarly as it has been mentioned earlier, that is, every condition is used once before any condition is used the second time. Block randomization may result in the design: D C A E B B A E D C.

Developmental research involves the special problems of age. When between subject design is used in this context, which is termed cross-sectional design, cohort effect can occur, that is nonequivalent groups may appear. When within subject design is used in developmental research, which is termed longitudinal design, attrition can be a problem. A combination of the two designs can be a solution, when cohort is selected every year, or a cohort is tested longitudinally.

5.3.3. Bias

Bias is a more general problem and its source can be the *experimenter expectancy* or the subject expectancy effect. In the first case, the experimenter behaves differently in the different research groups and affects the responses. If double blind is applicable, the procedure can control experimenter bias. Double blind means that the experimenter who meets the subject does not know which group the subject belongs to, therefore cannot affect the subjects' behavior.

In the second case, when *subject expectancy* is involved, participants sense the reason of the study and try to behave accordingly. Rosenthal (1966) called it evaluation apprehension, as the participant desire a good evaluation. In order to eliminate participant bias, demand characteristics (the aspects of study which would reveal the hypothesis) are controlled. Furthermore, manipulation checks are used to detect participant bias, for example the participants are asked about the possible aims of the study.

An interesting type of participant bias is the so called *Hawthorne effect* (Gillespie, 1988). The expression simply refers to the effect produced by the knowledge of being investigated. It was named after a famous study: between 1924 and 1933 workers' productivity was studied at Western Electric Plant in Hawthorne. The often referred study is called the Relay Assembly Test Room study, where the best working six female workers were investigated. Independently of the conditions, the six females produced more and more relays. Even when they were informed that the working hours would increase with 6 hours a week, and free lunches would not be available any more, their productivity increased. The only reason must have been that they were the studied group, who seemed important, and was measured.

Related reading: Sections "The validity of experimental research" and "Threats to internal validity" in Chapter five in the course book. Chapter six in the course book

6. Experimental designs

6.1. Single factor designs

A single factor experimental design involves only one independent variable. Four basic single factor designs are differentiated, as it can be seen on Figure 3.

6.1.1. Single factor with two levels

The experimental design can have only one factor with two levels, this is the simplest design. The two levels of the independent variables are either formed by manipulation or selected as subject factors. Manipulation may involve random assignment (independent group design), or assignment after matching on confounds (matched group design).When subject factors form the independent variable, nonequivalent groups design is the appropriate term to be used. While within subject single factor design is called repeated measures design. The results of any of the above listed designs are normally evaluated with a t-test, when the dependent variable is ratio or interval type.

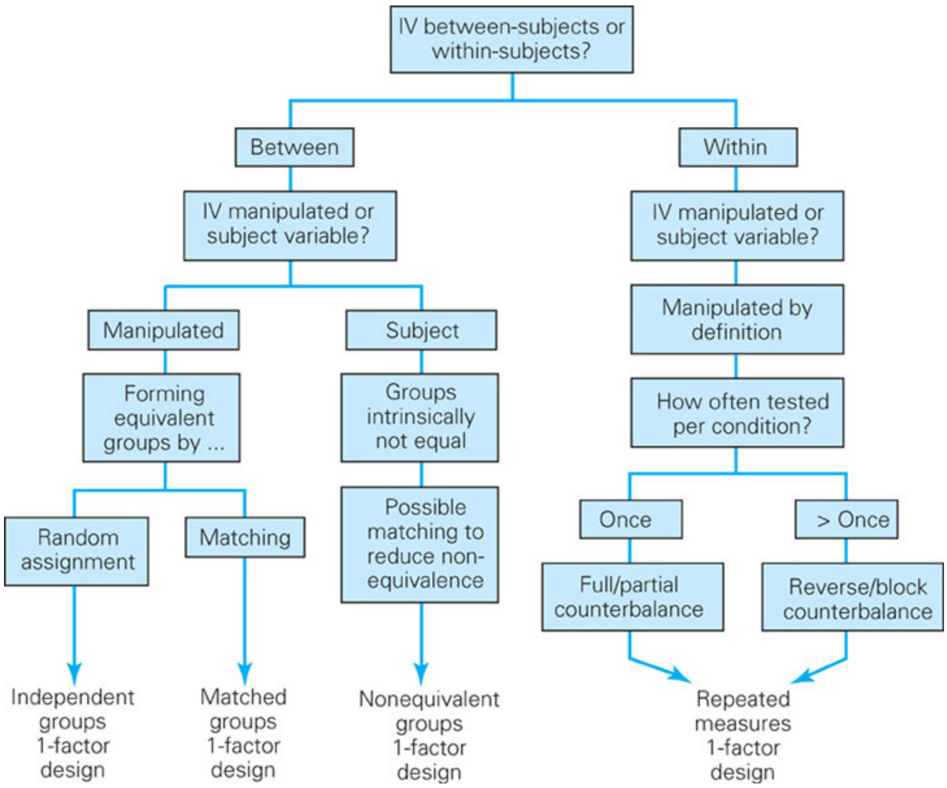


Figure 3.
Decision tree of single factor experimental designs (figure from the supplemental materials of the course book)

6.1.2. Single factor with more than two levels

Experimental designs with a single factor with more than two levels enables us to investigate the form of the relationship of the dependent and independent variables, if the independent variable is at least an ordinal type. Even in this case, the independent variable can create a within subject or a between subject design. The results of the single factor design with more than two levels are normally investigated with a one-way analysis of variance, when the dependent variable is appropriate.

6.1.3. Control group designs

The main characteristic of a control group is the presence of a group which does not get the treatment. There are basically three types: the placebo group, the waiting list group and yoked control group. Control group designs help the researcher identifying the real effect of a treatment beyond the effect caused by the participant expectations in change.

6.2. Factorial designs

Factorial design always involves more than one independent variable. The different basic designs are indicated in Figure 4.

6.2.1. Features of factorial design

The description of the actual design, using the prevalent notation, indicates the number of levels of each variable. For example a 4x2x3 design involves three independent variables with four, two and three values. The advantage of such a design is the study of interactions. The aim is not to study the effects of each independent variable separately, but to reveal their interaction, that is, to study whether and how one variable affects the effect of the other variable if it does so. The result can be an interaction, main effect(s), both, or no significant effect.

6.2.2. Types of factorial design

In a factorial design, any of the independent variables can represent either between or within subject factors. When all independent variables are within subject factors, the design is called a repeated measures design. Otherwise, the independent variables can be between subject factors which are manipulated yielding independent groups factorial design (random assignment) or matched groups factorial design (matching). On the other hand, the independent variables can be between subject factors which are subject factors, yielding nonequivalent groups factorial design. And finally, between subjects independent variables can include both subject and manipulated variables resulting the so called PxE factorial design. When both within subject and between subject variables are included in the design, depending on the latter, mixed PxE factorial (subject variable) or mixed factorial design (manipulated) is obtained. The notation PxE denotes person by environment design.

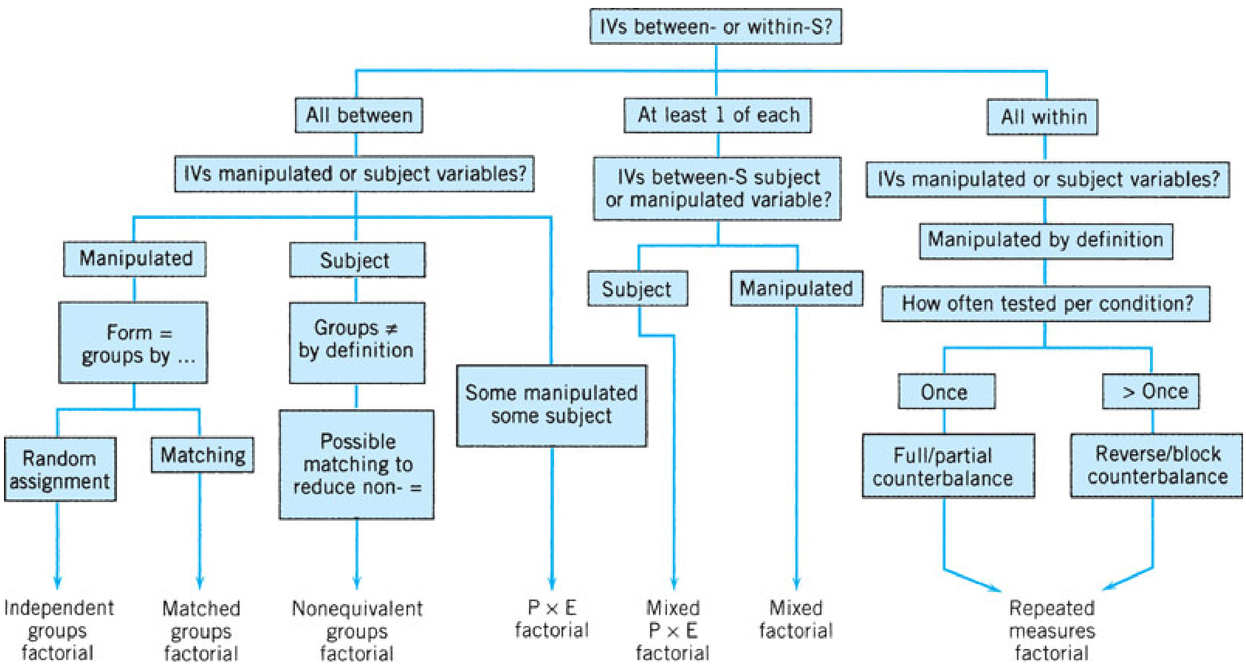


Figure 4.
Decision tree of factorial experimental designs (figure from the supplemental materials of the course book)

Related reading: Chapter seven and eight in the course book.

7. Correlational research

Along with the experimental approach, correlational research is developed as a branch of quantitative psychological research. In case of correlational research, naturally occurring relationships are studied. Such studies rarely allow us to draw causal conclusions. Notwithstanding, correlational research is valuable, because it can provide a good basis for experimental research (1); sometimes, only correlational studies can be carried out (2); and the obtained observation can be important by itself (3).

In the late 19th Francis Galton (1869, 1886) was keenly studying intelligence, and believed that intelligence is inherited. He developed a method to express the strength of co-relations. During his heredity studies he identified that there is a tendency towards the mean: tallest parents have less extremely tall children and shortest parents have less extremely short children. Galton called this phenomenon *regression to the mean*. Hence, when Karl Pearson developed a measure of correlation (see for e.g. Pearson, 1896), he named it "r", after regression, in honor of Galton.

The easiest way to study the intensity and type of an association, when continuous variables are measured, is calculating Pearson's r correlation coefficient. Correlation expresses the direction and strength of a relation with numbers between –1 and 1. Zero means no linear relation, smallest and largest numbers mean stronger association. Negative correlation means reverse function, positive correlation means direct functions.

From the visual approaches, the scatter plot can also give an idea of the relationship. When the cloud is circle-like, there is no sensible relation. The oval form of the cloud indicates meaningful relation.

When the association is notable, regression analysis provides a possibility to give predictions from the value of one of the variables to the value of another variable. When the association of more than two variables is investigated, multivariate analyses, such as multiple regression or factor analysis is required.

It is important to note, that although the terms independent and dependent variable are used in correlational research, normally casual conclusions cannot be drawn. The direction of the relationship is not evident. However, cross-lagged panel correlation may allow the researcher to make assumptions about directionality. But it is always possible, that a third variable, affects both variables. If a possible third variable is easy to note, partial correlation can measure its effect.

Related reading: Chapter nine in the course book.

8. Quasi-experimental designs and applied research

8.1. Quasi-experimental design

A study where the participants cannot be randomly assigned to groups or participants cannot be counterbalanced is understood to have quasi-experimental design. In such a study, typically pretest-posttest changes are investigated regarding the experimental and control group. The design can be time series or interrupted time series design, both involving several measurements before and after treatment, but in the latter, trends also can be evaluated.

A special type of quasi-experimental research, *archival research*, must be differentiated, where the researchers rely on data gathered for a former study. Sometimes the stored information is ready for analyses, but often content analyses should be applied first to data. Content analysis may introduce experimenter bias through the data selection and also through interpretation. The huge advantage of archival data is the enormous amount of available information. However, casual conclusion neither from archival research can be drawn.

8.2. Applied research

Applied research is developed on the ground of practical needs, in order to provide solutions for practical problems. Although, the motivation is different, applied research can also contribute to psychology theories, such as basic research. Applied research normally takes place on the field, as for example at a company, in a clinic, in jail, but sometimes also applied research can be carried out in a laboratory.

When an applied research is designed, special ethical issues (1), problems of between-subject design (2) and within-subject design (3) must be considered, and an optimal balance should be found between internal and external validity (4).

1. Participants often cannot be informed about the research, privacy may be violated and sometimes subjects feel forced indirectly for participation.
2. Random assignment is often not possible, therefore, nonequivalent groups are created and selection problem can cause loss of internal validity.
3. Similarly, often counterbalance neither can be properly carried out, causing sequence effect and attrition.
4. As researchers loose control over several external factors in the field, internal validity may decrease. At the same time external validity can be increasing based on the application.

8.3. Program evaluation

Program evaluation is a type of applied research, which is used to assess policies and programs. It may include needs analysis: the definition of the population who could benefit from a concrete program; program evaluation: whether a program is following the original plan, and if not, how it could be lead back to the predetermined path; and program evaluation. Needs analysis can use census data, survey on available resources, survey on participant needs, information forums (key informant, focus groups and community forums can be used). Program evaluation combines formative evaluation, summative evaluation and cost analyses. Both quantitative and qualitative research techniques are used.

Related reading: Chapter ten in the course book.

9. Small N Designs

The earliest studies of psychology report small N designs or single subject designs. In the early history of psychology, the data analysis techniques were not developed for large sample sizes, partly this was the reason for such studies. However, sometimes only few subjects are available, the cost must be reduced or the phenomenon is not so clear when general tendencies are looked at. The advantage of small N design is high individualsubject validity; on the other hand, clear disadvantage is the low external validity, and susceptibility to experimenter bias.

When only one subject is investigated, behavioral change is measurable. Therefore, the detection of a baseline level is essential. The simplest designs that can be used is A-B design, where A is the section where *baseline* is determined, B is another section where the treatment effect is registered. Maturation can also have a significant effect, therefore withdrawal design is justified. A-B-A design and A-B-A-B designs are examples for withdrawal design, which account for maturation. In *multiple baseline designs*, the baseline is determined several times. A third type of single subject design is *changing criterion design*. Such a design occurs in the context of shaping. When the required behavior is complex and cannot be learned at once, changing criterion design is used. After measuring the baseline level, a new measure is taken after treatment when certain criterions are fulfilled, and the next measure is taken when even stronger criterions are satisfied.

Case studies are well-known in clinical research. For example, Sigmund Freud described many case studies (e.g., Breuer & Freud, 1955). A common feature of such studies, that the detailed description and analysis of a single case is provided including history, treatment and result effects. Although case studies have law external validity, they can point at important features, co-relations and stimulate new research. Unfortunately, neither the description of the person (especially regarding old events), nor the description of the researcher is always precise. However, memory loss of the participant is smaller when traumatic events are recalled.

Related reading: Chapter eleven in the course book.

10. Observational and survey research methods

10.1. Observational research

Observational studies provide descriptions of behavior. Mostly, naturalistic observations are applied, that is, the researcher does not participate in the situation, and the participants are either unaware of or habituated to the presence of the researcher. Another type is the participant observation, which supposes that the researcher is an active member of the group, the amount of interference can be on a wide range.

Three major problems of observations are in observational research is observer bias, lack of control and subject reactivity. Observer bias can be reduced by behavior checklist (consisting of operationally defined behaviors), training of the observers and using more than one observer at a place. When more observers are present, interobserver reliability is calculated, that is normally the number of agreements. Time sampling and event sampling of the observed occasions can also be used to reduce bias, because if a sample is used, continuous recording is not necessary. Furthermore, ethical issues may also arise. In spite of all possible sources of bias, observational research is a good source of ideas for experimental research.

10.2. Survey research

Survey research aims at describing the opinion, attitude, self-described behavior of people. The most effective a survey is when the sample is representative. Probability sampling is used to ensure representativeness of a sample, either random (every member of the population has an equal chance to be selected), stratified (important groups have proportional representation in the sample) or cluster sample (when all members cannot be detected) can be used. The survey can be administered in an interview, by written questionnaires, on the phone and via internet.

Survey wording must be very careful in several respects, detailed below. *Survey questions* can be open ended to allow numerous possible answers, even answers the researcher could not think of. Therefore an open ended question is a good source for all possible answers, hence can be a ground for closed questions. Closed questions have a list of possible answers, and the subject must choose among them. Closed questions do not require further categorizing from the researcher, and the collected data is easy to handle. The simplest example is a yes or no question. However, closed questions must contain all distinguishable possible answers, and answers should not overlap. Whenever the researcher is not confident about the completeness of the list, partially open ended questions can be used, that is, the list of answers should include an "other" possibility.

A survey may also consist of several *statements*, where the subjects should indicate the degree they agree with the statements. Most often a Likert type scale is used including 5-9 points with two extremes, such as strongly disagree, strongly agree.

When the memory or knowledge of subjects is challenged, there must be a possible answer: "I do not know.". The researcher may want to know demographical information, such as age, income that may be *delicate information* for the participants. In such cases, questions about demographic information must come at the end of the survey. Asking about the date of birth is a better idea than asking for the age. And asking for a correct placement among income ranges is also less delicate than asking for an average monthly net income. In survey research, great care must be taken to avoid misunderstanding, social desirability and response acquiescence (a tendency to agree with every statement).

Although *wording* may not seem essential, it can cause misunderstanding, different understanding by different people, and the tendency to prefer one of the answers. To avoid such problems, the following advises should be considered:

- Do not ask ambiguous questions (regarding the wording).
- Ask one question at a time.
- Avoid leading questions, such as questions of lawyers, when the question appears as a part of a general idea.
- Use complete sentences.
- Avoid complexity.
- Avoid slang or jargon.
- Avoid abbreviations.
- Do not ask negatively phrased questions.
- Use balanced items.

Related reading: Chapter twelve in the course book.

11. Ethical issues in scientific research

Research planning must include a *cost-benefit* analysis regarding the risk for the participants and the possible values of scientific outcome. Potential participants must get *enough information* to be able to decide about participation. They must be informed about the possibility of leaving the study whenever they feel like doing so. And subjects must be ensured that refusal of participation has no effect on them. Special care must be taken for these issues when children are involved in research or people in defenselessness situations (in clinic, in jail). *Confidentiality* must be assured and promised.

Scientific fraud has several forms. Plagiarism involves the presentation of materials belonging to other as one's own. Data manufacturing and manipulation are in the group of *data falsification*. Although academic pressure may lead to scientific fraud, it is often discovered and has serious consequences, depending on the act and on the form.

Related reading: Chapter two in the course book.

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