1.3.2. Null and alternative hypotheses as well as significance

By conducting an experiment, the researcher tries to verify whether the empirical evidence is consistent with the assumed hypothesis. In statistics, it is impossible to show that any statement is undeniably true. However, there are ways to show that some dependencies are not true. In this part of the chapter, the main assumptions of statistical hypothesis testing are presented. Here, the null hypotheses can be distinguished according to whether there is no difference between the groups that are compared in the study. The null hypothesis allows to suggest that no effect is observed but the researcher usually wants to demonstrate that there are dependencies. Thus, there is an alternative hypothesis which predicts that there is a significant difference between the groups under study. This hypotheses is mainly the one that the researcher aims to support (Jackson, 2008). While conducting the experimental procedure, we want to reject the null hypothesis, which would indicate that the findings are consistent with the alternative hypothesis.

The concept of statistical significance is crucial in testing statistical hypotheses. If some difference is statistically significant, this means that it does not happen by chance. In social sciences, the usually chosen level of statistical significance (alpha level) is 5%. It allows the researcher to reject the null hypothesis and indicates that the probability that the tested dependence is due to chance is 5 in 100 (Jackson, 2008).

1.3.3. Data presentation and report structure (APA standards)

After planning, conducting the experiment and data analysis, the results should be properly presented. In this section, the principles of presenting and reporting results will be discussed. Creating the report follows the standards of scientific papers. The research should be fully clear for readers, the conclusions thoroughly explained and presented in a way that allows them to be compared to other studies. This is why the comprehensive standards of reporting are indispensable. The main rule is that all information relevant to the experiment should be included in the report.

The structure of a typical report follows the structure of scientific articles and is presented below:

- Introduction (literature review, main hypotheses)
- Method (design, participants, procedure)
- Results
- Discussion (interpretation, limitations)

The document should also follow the formal structure including: title, abstract, keywords, references and appendix.

Introduction

The first part of a report is the 'Introduction', in which the importance of the problem under study is shown. In this part, the 'Literature review' should also be presented—it is suggested to define the scope of the problem, its theoretical and practical aspects and to indicate what was the subject of research earlier and what remains unexplained. The main hypothesis should be formulated on the basis of the analysed theories. Thus, the introduction involves the description of the study goals as well.

Method

In the next part of the report, the implemented method(s) should be described. The 'Method' section should contain a description of the study participants, including information about their demographic characteristics (e.g. age, nationality, level of education), as well as aspects relevant to the study. Here, the procedures for selecting participants should be presented—the sampling method, time and place of collecting the data, agreements with participants and ethical and safety considerations. In the report, the number of participants taking part in the experiment, the number of participants in experimental and control groups as well as the number of participants that did not complete the experiment should be shown. The 'Method' section involves the inclusion and exclusion criteria for participants. Then, there should be a description of the sample—the number of participants in the study and the planned sample size. If such procedures were used, the methodological part of the report should include information on masking the purpose of the study, training to which collectors were subjected or additional methods. In this section, the research design (whether the between-subjects or within-subjects procedure was applied), the conditions of the study (natural or manipulated) and the assignment to different conditions (if applicable) are described. If the experiment includes manipulations/interventions, it should be precisely described what they consisted of and how they were applied—settings, the duration of exposure and the number of manipulations.

Results

The next section of the report focuses on the 'Results' section of the experiment. An accurate and impartial presentation of the results is the crucial part of the report. All the important results of the study should be presented

with attention to detail and as clearly as possible. In the report, data that are not consistent with the assumed hypotheses should not be omitted—the insignificant dependencies and small effect sizes should be mentioned as well. Raw data and additional materials may be included in the 'Appendix'. When reporting the results, it is recommended to reflect the sequence of the hypotheses presented earlier. When it comes to statistical tests, reporting involves a sufficient set of statistics that are indispensable to understand the outcome. The description should include the value of the test statistic, the degrees of freedom, the *p* value and the magnitude of the effect. The measures of effect size may also be added to this section.

Discussion

The next part of the report regards the 'Discussion' section. The next step, after presenting the results, is to interpret them and draw conclusions from the conducted experiment. It is important to keep this section consistent with the previous one regarding the results. In this section of the report, it should be indicated whether the findings support or do not support the hypotheses. If contradictory or unclear results are obtained, possible causes need to be indicated. Moreover, in the report, the results obtained in relation to the studies of other researchers are presented and the observed differences and similarities are explained. In general, the main implications of the study should be emphasized. In this section, the limitations and strengths of the study are given.

Example

Perception time in forming attitudes towards art

Abstract: In the study, it is examined whether an extremely short exposure to stimuli enables the formulation of aesthetic judgments. In order to determine the time of aesthetic experience formation, an experiment has been conducted in which 12 paintings were displayed during 40 ms. In the previous study, 40 ms was assessed as the minimum exposure duration to process the visual stimuli. The initial judgments were confronted with the judgments formed after longer exposure (10 s). By comparing long- and short-term exposure, it is possible to establish consistency of the observed judgments. The database comprises pairs of works of art by the same artists with a similar composition and auctioned at similar prices, which makes it possible to assess the consistency of judgments with regard to a particular

style. The experiment was conducted on a sample of 30 participants. The main findings allow to indicate that 40 ms is a sufficient time to formulate aesthetic judgment.

Keywords: art perception, formulating aesthetic judgments.

Introduction

When thinking of an aesthetic judgment, it must be considered how well a work of art expresses and influences others with feelings and emotion. The processes underlying the aesthetic experience have been described from both perceptual/cognitive and motivational viewpoints.

In previous research, it has been confirmed that ultra-short exposures (below 1 s) may be sufficient to formulate aesthetic judgements and attitudes. Cupchik and Berlyne (1979) assessed whether people are able to distinguish collative properties with presentation times of 50 ms. They have confirmed that this time allowed the participants to obtain relevant visual information. Locher, Krupinski, Mello-Thoms and Nodine (2007) noted that the time needed to form a significant holistic impression of the painting is about 100 ms.

The most extreme time range was tested in the study by Augustin, Leder, Hutzler and Carbon (2008). They found that 10-ms exposure may be enough to find traces of visual processing effects. In the same study, they confirmed such a significant effect after the presentation of 50 ms.

Main hypotheses

The previous study allows us to state that within the range of 50 to 100 ms, people are able to process visual stimuli and formulate judgment. We aimed to test if the shorter presentation time could be sufficient for similar effects to be observed.

The main hypothesis allows to indicate that a presentation time of 40 ms is sufficient to formulate aesthetic judgments.

Method

In the study the within-subjects, one-group pretest–posttest design was used. There was one independent variable (exposure time) with two levels (40 ms, 10 s). The dependent variable was the aesthetic pleasure measured as a self-reported assessment on the interval scale of 0 (not at all) to 10 (extremely pleasing).

1.5. Before the experiment (proper usage of the equipment, calibration, recording)

Proper usage of the equipment

The glasses should be properly set by adjusting the strip. The position of the glasses should be stable, and the participant is not allowed to change the position of the glasses during the experiment. After turning on the device, the range of the participant's view and the dot showing where the participant is looking at can be seen.

The proper positioning of the glasses is indicated by a green dot on the screen of the recorder (1). If the colour of the dot is not green (yellow or red), the position of the glasses has to be adjusted.

Figure 2. Positioning of the glasses

Source: Own elaboration.

After turning the device on, in the panel on the right, click on the 'NEW EXPERIMENT' button.

After that, you will be asked to name your experiment.

In the next step, a new participant can be added to the experiment. It should be ensured that the participant is added to the experiment. New experiments for new participants of the existing experiment are not to be created. Each new participant should be recorded separately (added as a new participant).

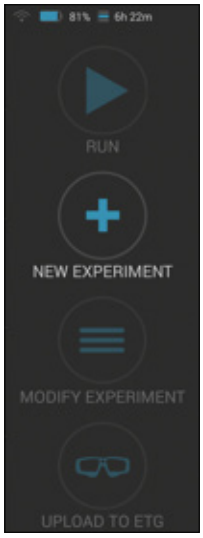

Figure 3. Creating a new experiment on the device

Source: Own elaboration.

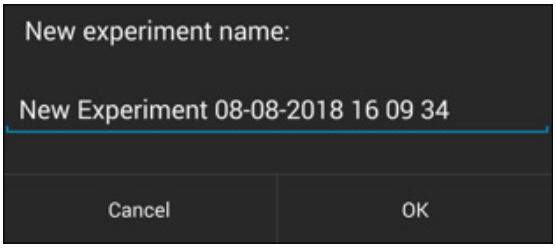

Figure 4. Naming the experiment

Source: Own elaboration.

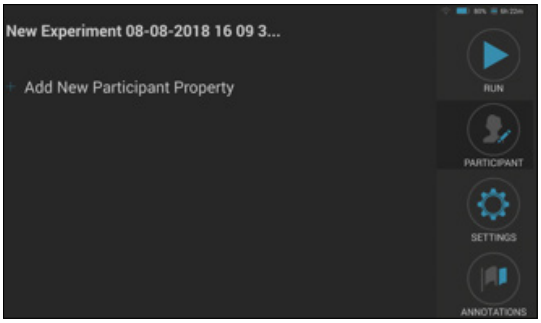

Figure 5. Adding a new participant—part 1

Source: Own elaboration.

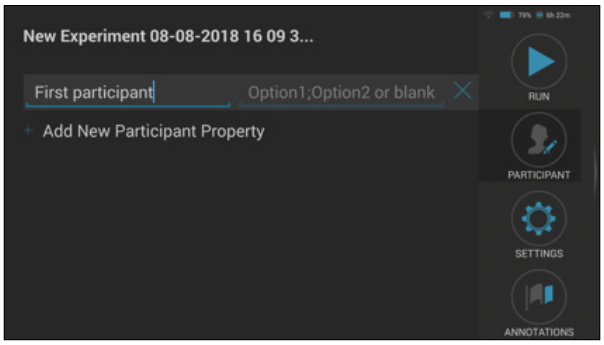

Figure 6. Adding a new participant—part 2

Source: Own elaboration.

Calibration

Calibration enables adjustment of the participant's gaze to the internal model of the eye-tracking software. It is a crucial step in conducting eye-tracking analysis because it helps in precisely tracking the movement of participant's eyes during the experiment (*BeGaze Manual. Version 3.7*, 2017).

In order to calibrate, the CALIBRATE icon on the right panel is to be selected. Before the calibration, the calibration type needs to be chosen (for 1 or 3 points). In this case, calibration will be presented with one point (landmark) that is marked as X.

Calibration should be arranged in the environment similar to real experimental conditions (position of the participant and distance from the object). It must be noted that the calibration should not be conducted with the visible scene of the planned experiment that could bias the experiment results. One or three landmarks (area that we can easily assess the gaze point) are required.

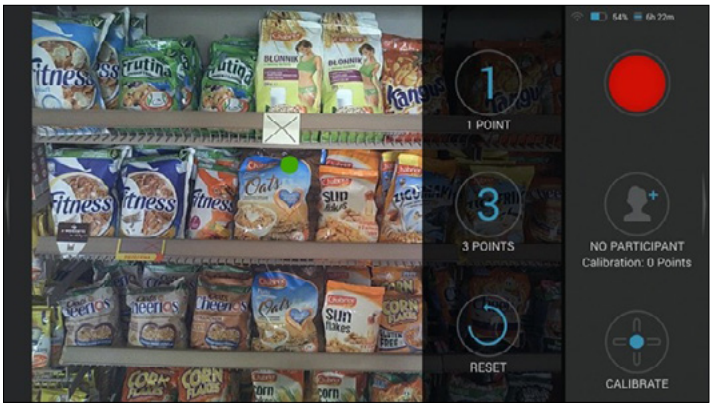

Figure 7. Calibration—step 1

Source: Own elaboration.

On the right panel, the instructions for calibration can be seen. The participant should look at the landmark (X). While the participant confirms gazing at the landmark, even if the dot is not exactly in the place of the landmark, the researcher should tap the screen of the recorder, freezing the image.

Figure 8. Calibration—step 2

Source: Own elaboration.

If the green dot is not exactly on the landmark, the researcher should move the '+' cursor to the landmark, using the touch-screen of the recorder.

Figure 9. Calibration—step 3

Source: Own elaboration.

In addition to measurement of the phase electrodermal response caused by the short-term stimuli, it is also possible to measure the response caused by the sustained stimuli (lasting over a long period of time). In this case, the change in tonic level (SCL) requires measurement. The change in tonic level is defined as the difference in its level between at least two points in time.

The measures of the tonic and phase electrodermal activity have specific, typical values (Table 1). It should be noted, however, that the electordermal reaction is very individual. It depends, inter alia, on: age, sex, race or the characteristic properties of the skin regarding the person under study (Cacioppo et al., 2007).

Table 1. Electrodermal measures, definitions and typical values

Measure	Definition	Typical values
Skin conductance level (SCL)	Tonic level of skin electrical conductivity	2–20 microSiemens
Change in SCL	Gradual changes in SCL measured at two or more points in time	1–3 microSiemens
Frequency of NS-SCRs	Number of SCRs in absence of identifiable eliciting stimulus	1–3 per minute
SCR amplitude	Phasic increase in conductance shortly following stimulus onset	0,1–1 microSiemens
SCR latency	Temporal interval between stimulus onset and SCR initiation	1–3 seconds
SCR rise time	SCR rise time	1–3 seconds
SCR half recovery time	Temporal interval between SCR peak and point of 50% SCR amplitude recovery	2–10 seconds

Source: (Cacioppo et al., 2007, p. 165).

Where is electordermal activity measured?

Electrodermal activity is measured on the skin surface (Strelau, 2006). Due to the fact that the highest sweat gland densities are on the hands and feet, these parts of the body are the main place for physiological measurements. However, the clear advantage of the hand in this respect is a consequence of the much easier usage of the measuring equipment. There is no clear suggestion in the literature as to on which hand the skin's electrical activity should be measured. The most often, the non-dominant hand is used for practical reasons. Nonetheless, the areas of the hand on which the measurement should be performed are relatively, precisely defined. These are the distal phalanges and the middle phalanges on the index and middle fingers, as well as the ball of the thumb and the little finger. Alternatively, the measurement can be carried out on the wrist. The measurement is taken by attaching electrodes to skin surface. The areas of the hand on which it is possible to measure electrodermal response (attach electrodes) are shown in Figure 3.

Figure 3. Locations for recording electrodermal activity

Source: Training materials of the NuroDevice company.

When deciding on the places where electrodermal activity is recorded, the following conditions should be taken into account:

1) recording the electrodermal activity from the subject's fingers gives a good signal (good data acquisition) but may prevent the subject from moving his/her hand freely;
2) recording the electrodermal activity from the subject's wrist makes it less difficult for the subject to move the hand, but gives a weaker signal (poorer data acquisition).

What equipment is used to measure electrodermal activity?

Measurements of electrodermal activity is performed while a small current is flowing through the skin from an external source. Therefore, this measurement cannot be done without dedicated equipment. It requires the use of special electrodes, electrode gels and recording devices. Its main element is the so-called biological signal acquisition station. The electrodes are connected to this station by a wire which, in turn, are attached (most often) to the hand of the participant under study. The obtained data is sent from the acquisition station to a computer, on which appropriate software is installed and allows for analysis. Such a set of apparatus allows to conduct research during which the participants are not required to move around.

On the other hand, research conducted in natural conditions, requiring the movement of people (e.g. inside a store), requires a slightly different configuration

of the apparatus. In that case it is impossible to connect the electrodes directly to a small device that is attached to the subject's forearm with a band. It records electordermal activity data. Then, this data is sent to the computer (see: Figure 4).

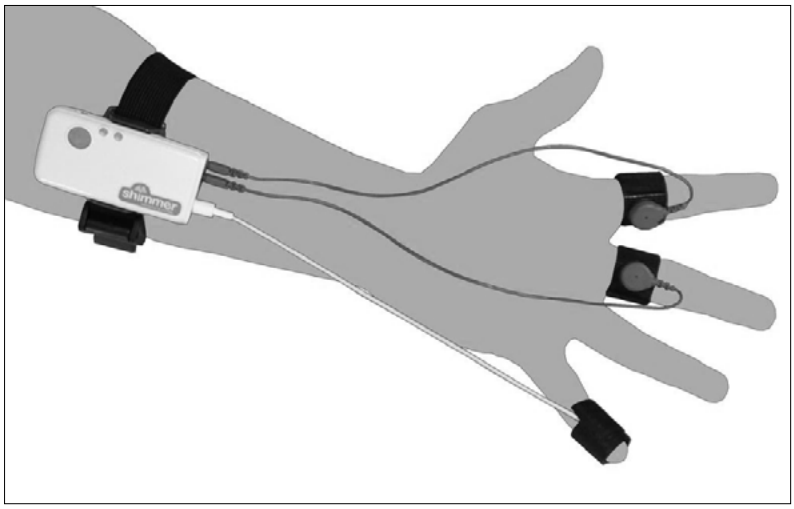

Figure 4. Example of the device used to detect electrodermal activity

Source: (Hernando-Gallego, Artés-Rodríguez, 2015).

The available equipment for analysis of electordermal activity is characterised by a relatively low cost (compared to other devices for physiological measurements) of purchase and operation. After the initial expense related to the acquisition of the measuring equipment itself, further use requires periodic purchases of appropriate consumables (gel or electrodes). Moreover, the EDA measurement is non-invasive and carries no risk to the health or life of the test subjects.

What needs to remembered when conducting electrodermal activity research?
The proper use of psychophysiological methods—including measurement of electrodermal activity—requires the application of several fundamental principles (Białowąs & Szyszka, 2019). First of all, one needs to **design an experiment in such a way that makes it possible do determine whether a given SCR is event-related (experiment related) or non-specific.** If the criteria in the experiment are too loose, one risks including non-specific SCRs into the analysis for event-related SCRs, and erroneously, this could led to misleading results. On the other hand, strict criteria may end in missing many ER-SCRs to meet the adopted criteria by wrongly discarding or misclassifying them as NS-SCRs (Braithwaite, Watson, Jones, & Rowe, 2015). Apart from a proper experiment design, there is also a set of good practices that facilitate electrodermal activity testing. They are the following:

1) the device should be put on the participant a few minutes before the test—this will improve the contact of the electrodes with the skin;
2) the respondent should be asked to perform an exercise, e.g. breathe in and out deeply (this will increase the EDA signal);
3) the right temperature should be set in the room—optimally, 22–24°C;
4) the number of artifacts related to movement should be reduced;
5) the presence of physiological activities of the body should be noted (coughing, deep inhalation, conversation)—they cause the generation of SCR;
6) a larger number of people should be recruited for the research—approx. 10% of the population is hyporesponsive.

After the examination, attention should also be paid to the record of the obtained electrodermal activity. Recordings that raise doubts should be excluded. Below, in Figure 5, a correct record of electrodermal activity is presented. In red, phase reactions are indicated. Each of them are marked with a 'drop'. Whereas in Figure 6, an erroneous record is shown. It results from the loss of contact between the electrodes and the palm of the participant at some point of the test.

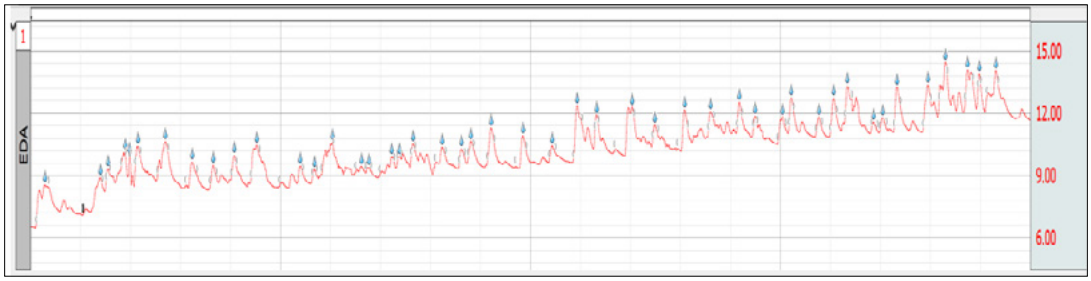

Figure 5. Record of correct tonic and phase electrodermal reaction

Source: (Pierański, 2019, p. 184).

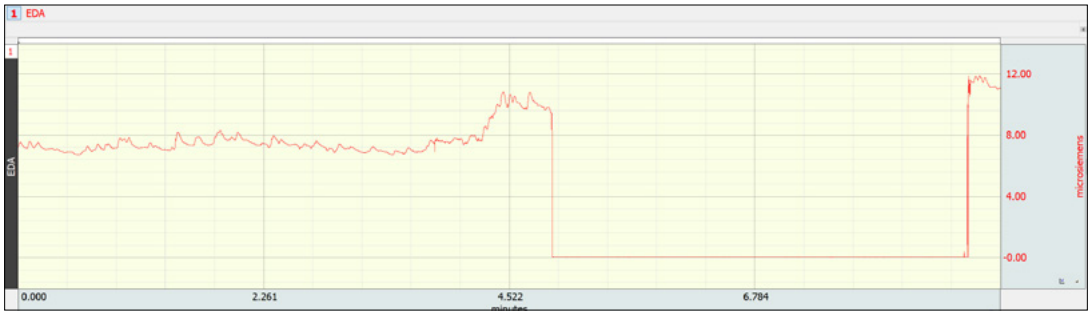

Figure 6. Record of electrodermal reaction indicating loss of contact between electrodes and skin of the participant

Source: (Pierański, 2019, p. 181).

that does not mean that the significance value equals zero. That is just the way SPSS tells us that the significance value is below .001. Thus, in accordance with the output, it can be concluded that the significance value is very small and, for sure, lower than .05. Therefore, at the significance level of .05, the null hypothesis of the test that there is no difference in mean food waste quantities between the groups can be rejected. So, it can furthermore be concluded that there is at least one group in which mean food waste quantity is different than in the other age groups (generations).

Post hoc analysis provides scrutinized insight into differences between pairs of groups. As a result, the significance value (see Sig. column in Post hoc analysis) can be observed for each age group compared to other age groups. In the presented example, it can be seen that all significance values are less than .05, except for the value use to compare age groups (generation) 1 and 4 (p = .469). Therefore, for instance, it can be assumed that the average quantity of food waste per month, per person from generation 1 is statistically different compared to generations 2 and 3, respectively. However, at the significance level of .05, the hypothesis cannot be rejected that there is no statistically significant difference between generations 1 and 4 regarding the average quantity of food waste per month, per person.

ANOVA
Food waste gr

	Sum of squares	df	Mean square	F	Sig.
Between groups	3747782.985	3	1249260.995	126.044	.000
Within groups	1912881.745	193	9911.304		
Total	5660664.731	196			

Post hoc tests

Multiple comparisons
Dependent variable: Food waste gr
Tukey HSD

(I) Generation	(J) Generation	Mean difference (I -J)	Std. Error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
1	2	−101.295*	19.719	.000	−152.40	−50.19
	3	−358.938*	20.270	.000	−411.47	−306.41
	4	−28.635	19.719	.469	−79.74	22.47
2	1	101.295*	19.719	.000	50.19	152.40
	3	−257.642*	20.457	.000	−310.66	−204.63
	4	72.660*	19.911	.002	21.06	124.26
3	1	358.938*	20.270	.000	306.41	411.47
	2	257.642*	20.457	.000	204.63	310.66
	4	330.302*	20.457	.000	277.29	383.32
4	1	28.635	19.719	.469	−22.47	79.74
	2	−72.660*	19.911	.002	−124.26	−21.06
	3	−330.302*	20.457	.000	−383.32	−277.29

Figure 22. Output of one-way ANOVA in SPSS

Source: The authors' own elaboration.

Testing hypotheses in Excel

In order to perform analysis of the same dataset in Excel, collected data has to be prepared for analysis, i.e. collected data has to be classified into columns that represent groups (Balakirshnan, Render, & Stair, 2007; Winston, 2016; Fraser, 2016). In our case columns will represent groups by age—generations of consumers. Therefore, in this case, the collected data will be classified into four columns and each column will be labelled according to consumer generation (in Figure 23, see title of columns in row 3). Then, all observed values will be entered for each generation of consumers. For instance, if a certain respondent is from generation 2 (age 26-40) and wastes 407 grams of food per month, his/her data is entered into the second column—'Group 2 (26-40)' (in Figure 23, see row 15). In the SPSS dataset, data on this respondent was entered as a simple observation in a single row as 2 and 407 (see Figure 15, row 64).

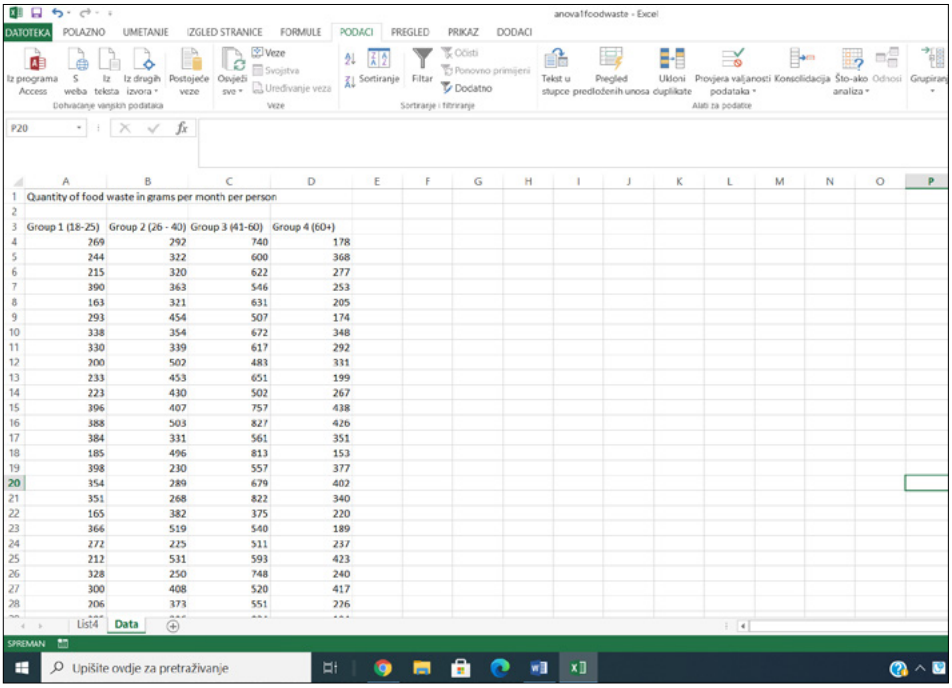

Figure 23. Excerpt from dataset for one-way ANOVA of food waste according to age

Source: The authors' own elaboration.

Then, 'Data tab' has to be selected and 'Data Analysis' (within Analysis group of commands) clicked. (Note that Data Analysis pack is not defalult package, you have to install it in your Excel). From among the list of methods, 'Anova: Single Factor' is chosen (see Figure 24).

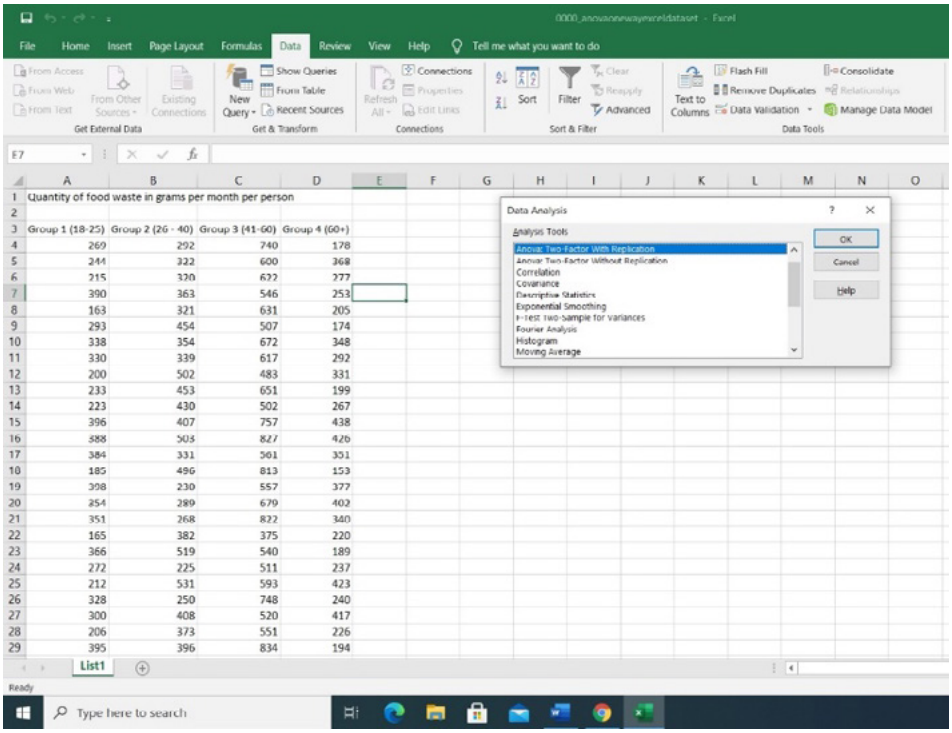

Figure 24. Data analysis tab in Excel—selection of ANOVA method: Single Factor

Source: Authors' own elaboration.

In the dialogue box of Anova: Single Factor—configuration has to be carried out as follows (see Figure 25):

- input range of the dataset including labels, in this example—A3:D55;
- position of data labels, in this example—First Row (there are names of the observed groups);
- way of organising groups of data, in this case, data is organised in columns, therefore, 'Columns' is chosen;
- output range—data can be choosen to be shown at some position in the active worksheet. Then, the exact cell, from which our results are going to be presented (such as F3), has to be specified; but in this case, we rather specified 'New worksheet' was indicated as the location for results. A name for the output can be specified (in this example—'Anova1');
- finally, the level of significance, i.e. alpha value. The default value, already set to .05, can be used.

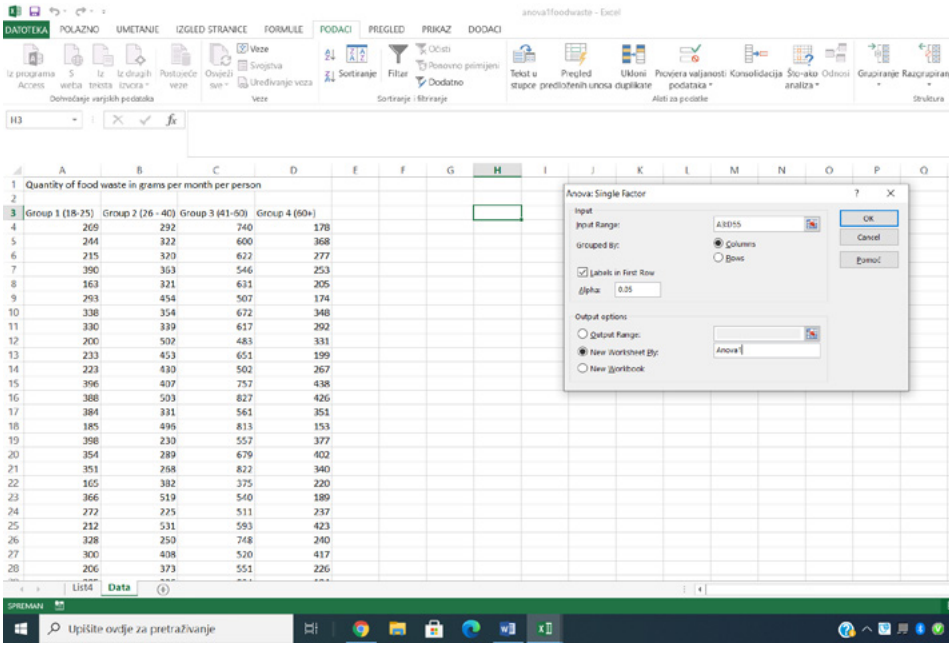

Figure 25. Dialog box—ANOVA: Single Factor

Source: The authors' own elaboration.

In Figure 26, the results of data analysis are shown, and the results can be interpreted. First of all, basic descriptive statistical data on each age group is obtained (see SUMMARY). From this part, it can be read how many respondents are in which group, then, what the average food waste in each group is, as well as the variance within each group. For instance, the lowest average of 261.88 grams of food waste per person, per month is shown in 'Group 1' (aged 18–25). The highest average value is in 'Group 3' (aged 41–60) and amounts to 620.82 grams a month, per person. In addition, ANOVA results are shown. In this table, the most important reading is *p*-value, because using this value, it can be decided not to reject or to reject the null hypothesis. In this case, the *p*-value is $3.08*10^{-45}$, or if rounded and truncated to four decimal points, the *p*-value is: .0000. However, the more precise would be if it were said that the *p*-value is lower than .0001 (*p*-value <.0001). In this way, it can be concluded that the significance value is much lower than that of .05. Consequently, that result means that the null hypothesis H_0 can be rejected and that there is no difference in mean food waste quantities between groups. In other words, at a significance level of .05, it may be concluded that there is at least one group in which mean food waste quantity is statistically different than in the other age groups (generations).