

# **Consumption of Energy Drinks**

### A Statistical Analysis of Consumer Behavior



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#### **1. Introduction**

This report aggregates the results and analyses of the quantitative research project for the course "Consumer Behavior Research Methods" at the Chair of Marketing of the Technical University of Munich in the Fall Term of 2016/2017.

First, a questionnaire was designed aiming to investigate the consumption behavior consumers exhibit regarding energy drinks.

Second, said questionnaire was used to acquire data from a sample using non-probability convenience sampling (based on availability of participants).

Third, the data was accumulated across class participants, formatted, and then analyzed as a whole. The analyses were conducted with SPSS. Performed analyses include frequency measures, descriptive statistics, contingency tables, comparing sample parameters to estimate population values and a factor analysis.

Total sample size was n=795. Analysis will only be conducted for valid responses in all tasks. All tests will be conducted at a 5% significance level, unless stated otherwise.

Identifiers of figures from SPSS outputs are in German, but all figures are labeled in English (consistent numbering throughout the report).



#### 2. Questionnaire about Energy Drinks

This survey attempts to collect information about the consumption of energy drinks. By participating in this survey, you help us to understand how and why energy drinks are consumed.

As we are interested in your honest opinion, there are no right or wrong answers.

Participation in this research study is completely voluntary. You have the right to withdraw at any time or refuse to participate entirely.

All data obtained from participants will be kept confidential and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones).

If you have questions regarding this study, you may send an email to niklas.goeke@tum.de

I have read the information above and hereby give my informed consent participating in this study.

Yes

No



1) Do you consume	energy drinks?						
O YES	${ m O}~{ m NO}$ $ ightarrow$ (If you answer is "No", please (	go to question 24)					
2) How did you get	to know energy drinks?						
O Friends/Family O Web/Social networks O Events							
<b>O</b> Promotion	<b>)</b> Promotion <b>O</b> Advertising/Sponsorships						
3) How often do you	u consume energy drinks? (just one answer)						
O Many times a day	O Once a day	O Many times a week					
O Once a week	O Many times a month	O Once a month					
O Seldom							
4) In which occasion	n(s) do you consume energy drinks? (more	answers are allowed)					
<b>O</b> In the disco	O Before an evening out	O To drive					
O When you are thir	orsty O To do sport	O To study					
O Other:							
5) Why do you cons	sume energy drinks? (more answers are allow	red)					
O More concentration	on O Good fe	eling					
O Quicker reaction	O Quench	your thirst					
O Better performance	ce O Taste						
O More energy	O Trend						
O Other 1:	O Other 2:						
6) If you consume e	nergy drinks, do you observe the benefit	s you wanted to get?					
O Always	O Often O Sometimes	O Never					
7) What do you thin	nk about the effectiveness of energy drinl	<u><s< u="">?</s<></u>					
O They_are effective	O They_are effective O It is just a psychological matter O They do not work						



8) W	/here do y	/ou buy	energy	drinks?	(more answer	s are allowed)
------	------------	---------	--------	---------	--------------	----------------

O Supermarket	O Discount	O Bar/Pub
O Vending machine	O Disco	O Service station

**O** Other: \_\_\_\_\_

9) What do you think is an appropriate price for a can at the supermarket?

**O** Less than 0.50€ **O** Between 0.50€ and 1€ **O** Between 1€ and 1.50€

O Between 1.50€ and 2€ O More than 2€

#### 10) If you consume energy drinks, which IMPORTANCE do the following ATTRIBUTES have in

#### your choice?

(give an evaluation from 1 to 9 where 1=less and 9=a lot)

	Less		Sufficiently			A lot			
	1	2	3	4	5	6	7	8	9
It provides the benefits I wanted									
The brand is known									
Packaging									
Availability									
Price									
Variety of products									
Taste									
Healthiness									
Sparkling									
Freshness									
Color of the beverage									
Calories									
Easiness to digest									



11) Which of these ene	ergy drink brands	s do you know? (more a	nswers are allowed)	1		
O Blitz!	O Boost	O Rockstar	O Burn	O Dark dog		
O Mixxed up	O Monster	<b>O</b> Piranha	O Effect	O Redbull		
<b>O</b> Other 1:	<b>O</b> Other 2:					
12) <u>Which of these bra</u>	nds have you co	nsumed in the last yea	<u>r? (</u> more answers a	re allowed)		
O Blitz!	O Boost	<b>O</b> Rockstar	O Burn	${f O}$ Dark dog		
O Mixxed up	O Monster	<b>O</b> Piranha	O Effect	O Redbull		
O Other 1:	<b>O</b> Other 2:					
13) Who usually purcha	ases the energy o	drinks that you consum	ie?			
O Myself	0	A family member				
<b>O</b> A friend/roommate	0	Other:				
14) <u>What do you do if y</u>	you don´t find yo	our favorite energy drir	<u>ık?</u>			
O I look for it in anothe	er place	<b>O</b> I buy an	other taste (sam	e brand)		
O I do not buy any oth	er brand	<b>O</b> I have a	second preferer	nce		
<b>O</b> I buy the one which	costs less	O I buy a r	andom one			
15) How often have yo	u changed the b	rand of energy drinks i	n the last year?			
O Very often O	) Often	O Sometimes	O Rarely	O Never		
16) If you have change answers are allowed)	d the brand in th	e last year, for which r	eason do you do	<u>) it?</u> (more		
O I want variety	<b>O</b> Propen	sity towards new prod	ucts O Pr	omotions		
O I was disappointed	<b>O</b> The one	e who purchase choose	e O Su	ggestions		
O I don't find my favor	ny favorite O Advertisement O Price					

**O** Other:\_\_\_\_\_



17) Which two energy drinks do you mainly consume?

Drink 1: \_\_\_\_\_

Drink 2: \_\_\_\_\_

#### 18) WITH REFERENCE TO THE BRAND of DRINK 1 THAT YOU USUALLY CONSUME (question

17), how important are the following attributes?

Sufficiently A lot Less 1 2 3 4 5 6 7 8 9 It provides the benefits I wanted The brand is known Packaging Availability Price Variety of products Taste Healthiness Sparkling Freshness Color of the beverage Calories Easiness to digest

Drink 1: \_\_\_\_\_

Do you have any other comments?



#### 19) WITH REFERENCE TO THE BRAND of DRINK 2 THAT YOU USUALLY CONSUME (question

#### 17), how important are the following attributes?

	Less		S	Sufficiently			A lot		
	1	2	3	4	5	6	7	8	9
It provides the benefits I wanted									
The brand is known									
Packaging									
Availability									
Price									
Variety of products									
Taste									
Healthiness									
Sparkling									
Freshness									
Color of the beverage									
Calories									
Easiness to digest									

Drink 2:\_\_\_\_\_

Do you have any other comments?

#### 20) In general, how you satisfied are you with the drinks that you consume?

Drink 1	Not at all								A lot
	1	2	3	4	5	6	7	8	9

Drink 2	Not at all								A lot
	1	2	3	4	5	6	7	8	9



Do you think that the energy drinks are harmful for the health? If you your answer is "No",							
please continue with question 23							
21) O YES	O NO	O I do not kn	ow				
22) If yes, in which circ	cumstances? (m	nore answers ar	e allowed)				
O If excessively consul	med	O If co	onsumed with	medicines			
O If consumed with al	O If consumed with alcoholic drinks O If consumed with smoke						
O Other:							
23) If yes, which proble	ems do you thi	<u>nk they can c</u>	cause? (more ans	wers are allowed)			
O Irritability	O Inson	nnia	O Gas	trointestinal disturbs			
<b>O</b> Hypertension	O Tachy	ycardia	O Oth	er:			
24) <u>Which change(s) o</u> <u>brand?</u> (more answe	r innovation(s) rs are allowed)	would you ir	ntroduce to the	e industry / your favorite			
O More advertisemen	t <b>O</b> More	e tastes/varia	tions	O Resalable package			
O Bottle of ½ liter	O Can c	of 0.33cl		O More promotions			
O Less sparkling drinks	s <b>O</b> More	e info on the i	ngredients	O Other:			
PERSONAL INFO	<u>RMATION</u>						
Sex: O Male	O Female						
Year of birth:							
Nationality:	_						
Are you currently: <b>O</b> A	student <b>O</b> F	ull-time emp	loyed <b>O</b> Part	-time employed <b>O</b> Other			
What is the highest de	gree of educat	ion you have:	completed?				
O High-School O Bad	chelor ´s degre	e O Master	´s degree				
Hobby: <b>O</b> travel <b>(</b>	O Technology	O Cooking	O TV/Cinema	O Reading			
O Sport,	, which one?						



Do you have some other comments that you to want to tell us?

#### THANK YOU A LOT FOR YOUR COLLABORATION!



#### **3.** Questionnaire Analysis

Before all participants received a final version of the questionnaire for data collection, we analyzed and corrected a biased and incomplete variant of it. We were also asked to identify the screening question, as well as questions suited for a factor and cluster analysis, respectively.

#### 1. Main mistakes of previous questionnaire & improvements

Initially, no introduction to the questionnaire was provided. This should always be included to provide participants with necessary background information about the study, for example how the data will be used, whether anonymity is guaranteed and what the purpose of the study is.

Moreover, including a question of consent here ensures that participants really volunteer the information they are about to provide.

Other mistakes, which repeatedly occurred were:

- No directions for participants, who had to skip certain questions (for example by answering the screening question with "No").
- Missing information about how many answers to check (one or multiple).
- Ambiguous answer options ("often" is subjective, for example).
- Awkward and imprecise question formulations
- Imbalanced scales (for example starting acceptable prices at 0.5€, but not lower, with an open end for prices higher than 2€).
- Incompatible attributes (less vs. good, for example, instead of less vs. a lot).
- Omitting an "I don't know" option, which makes it less likely participants will skip a question.
- Spreading the collection of personal information throughout the questionnaire, instead of collecting it centrally in one place at the end (which maximizes chances of obtaining all relevant information).

#### **2. Screening Question**

The screening question was "Do you consume energy drinks?" People, who do not consume energy drinks, will not have much information to provide about the consumption of such beverages. Therefore, these participants are directed right to the last question, about which changes they would like to see in the energy drink industry. The answers can be used to infer what requirements would need to be fulfilled to make them consume energy drinks.

#### **3. Factor Analysis Questions**

A factor analysis tries to determine the underlying structure of a data set, by finding latent variables, which are correlated with the observed ones. The results can then be used to



reduce the number of variables altogether, by representing some of the originally measured variables as a linear function of a newly established, latent variable.

Therefore, factor analysis questions will usually be presented in the form of "question batteries," where respondents rank multiple items on an ordinal or interval scale (for example Likert scale). The correlation among these can then be measured and used to extract the factors, which later turn into the macro-variables of the new model.

Questions in this questionnaire, which can be used for a factor analysis, are:

- Question 10
- Question 18
- Question 19

We will conduct a factor analysis for question 18 later on.

#### 4. Cluster Analysis Questions

A cluster analysis is similar to a factor analysis in that it also aggregates the available data, yet it does not cumulate information on the variable, but on the observation level. With hierarchical clustering, observations are grouped into categories based on the differences in their values. This can be used to determine customer profiles and types, for example.

Cluster analysis questions therefore allocate respondents into one or several categories at once, to make sure the entire sample can be spread across the defined clusters.

Questions in this questionnaire, which can be used for a cluster analysis, are:

- Question 2
- Question 3
- Question 4
- Question 5
- Question 6
- Question 9
- Question 11
- Question 12
- Question 15
- Question 24



#### 4. Frequency Analysis

The following frequency measures were computed for questions 3, 4 and 9, which represent the amount of consumption, occasions when energy drinks are consumed and prices considered as appropriate, respectively.

#### **1.** Question **3**: Amount of consumption

This variable is ordinally scaled. Regarding how often they consumed energy drinks, 678 respondents gave valid answers.

Almost one third seldomly consumes energy drinks (less than once per month), and slightly over one quarter reports to consumer energy drinks once a month. This means over 50% of our sample drinks energy drinks less than twice per month. Only 2.1% reported consuming energy drinks multiple times a day.

		Häufiakeit	Prozent	Gültige Prozente	Kumulierte Prozente
Gültig	Many times a day	14	1,8	2,1	2,1
	Once a day	26	3,3	3,8	5,9
	Many times a week	53	6,7	7,8	13,7
	Once a week	93	11,7	13,7	27,4
	Many times a month	106	13,3	15,6	43,1
	Once a month	186	23,4	27,4	70,5
	Seldom	200	25,2	29,5	100,0
	Gesamt	678	85,3	100,0	
Fehlend	System	117	14,7		
Gesamt		795	100,0		

Amount Consumption

Fig. 1: Frequency table for amount of consumption



The bar chart shows a heavily left-tailed, negatively skewed distribution for the amount of consumption, with over 50% of the data concentrated on the far right side of the spectrum.

It is interesting to note here, that the right side represents less consumption, which is counter-intuitive and makes visual interpretation harder.



Amount Consumption

Fig. 2: Frequency bar chart for amount of consumption

#### 2. Question 4: Occasions for consuming energy drinks

Different consumers turn to energy drinks for different reasons and on various occasions. Out of our sample, 667 participantes reported valid answers for this questions. 128 observations are missing.

Fallzusammenfassung								
	Fälle							
	Gültig Fehlend Gesamt							
	N Prozent		N Prozent		Ν	Prozent		
\$Uses <sup>a</sup>	667	83,9%	128	16,1%	795	100,0%		

a. Dichotomie-Gruppe tabellarisch dargestellt bei Wert 1.

Fig. 3: Sample size for uses of energy drinks



However, since multiple answers were possible for this question, a total of 1318 observations were made, equaling almost 2 different choices of use cases per respondent on average.

Almost 50% of participants reported consuming energy drinks at the disco, making this the most common use case. The second most common occasion is while studying, with 41.8%, followed closely by an evening out with 37%. Driving is another popular use case, with almost one third of respondents reporting to consume energy drinks for this occasion.

It is interesting to note that only 11.5% of respondents drink energy drinks to quench their thirst. Most of the reported use cases are scenarios where wakefulness and focus are required, which indicates respondents from the sample consume energy drinks more for the "energy" factor than the "drink" factor.

		Antw	orten	Prozent der			
		Ν	Prozent	Fälle			
\$Uses <sup>a</sup>	Disco	333	25,3%	49,9%			
	Evening Out	247	18,7%	37,0%			
	To drive	206	15,6%	30,9%			
	Thirsty	77	5,8%	11,5%			
	To Do Sport	118	9,0%	17,7%			
	To Study	279	21,2%	41,8%			
	Other Occasions	58	4,4%	8,7%			
Gesamt		1318	100,0%	197,6%			

Häufigkeiten von \$Uses

a. Dichotomie-Gruppe tabellarisch dargestellt bei Wert 1.

Fig. 4: Frequency table for uses of energy drinks



The pie chart for the frequencies of use cases highlights the fact that 80% of occasions of use relate to these 4 activities well.



Fig. 5: Frequency pie chart for uses of energy drinks



The bar chart does not reflect the information too well here, since the variable is nominal and we talk about kurtosis or skewness. However, it highlights the similar frequencies of studying and spending a night out, as well as shows ratios, such as disco being mentioned about 3 times as much as sport.



#### Fig. 6: Frequency bar chart for uses of energy drinks

#### 3. Question 9: Appropriate price

85% of the sample reported valid answers to the pricing question. The data groups densely around the center of the interval scale, with the center category, 1 to 1.5€ being the most frequently mentioned category (40.6%). The two categories bordering on the middle one show a strong tilt towards lower prices. The category of 0.5 to 1€ is being considered as appropriate prices twice as often as 1.5 to 2€. Only 6% of respondents consider the most extreme price categories as fair, with 3.8% opting for less than 0.5€ and 2.1% opting for more than 2€.



Appropriate Price								
				Gültige	Kumulierte			
		Häufigkeit	Prozent	Prozente	Prozente			
Gültig	Less than 0.50€	26	3,3	3,8	3,8			
	Between 0.50€ and 1€	242	30,4	35,6	39,5			
	Between 1€ and 1.50€	276	34,7	40,6	80,1			
	Between 1.50€ and 2€	121	15,2	17,8	97,9			
	More than 2€	14	1,8	2,1	100,0			
	Gesamt	679	85,4	100,0				
Fehlend	System	116	14,6					
Gesamt		795	100,0					

Fig. 7: Frequency table for appropriate prices of energy drinks

The bar chart reveals a distribution reminiscent of a normal distribution, albeit a very peaked and right-skewed one.



Appropriate Price

Fig. 8: Frequency bar chart for appropriate prices of energy drinks



The same bar graph computed in Excel shows the 2:1 ratio of category 2 (0.5-1 $\in$ ) to category 4 (1.5-2 $\in$ ) well.



Fig. 9: Frequency bar chart for appropriate prices of energy drinks (in Excel)

The pie chart, also computed in Excel, visually reveals that over 75% of respondents perceive prices between 0.5 and 1.5€ as fair. However, this information is not suited enough to determine a precise price, since only ranges are given.







#### 4. Mean, Median, Mode and other measures of central tendency

Since occasion of use is a nominal variable, computing measures of central tendency would not make any sense - the different manifestations of the variable can't be ranked or ordered. Amount of consumption is an ordinal variable - we cannot give exact intervals, since "many times a day" and "seldom" are not precise frequencies, but we can rank the various categories by absolute recorded frequency. Appropriate price is an interval variable with open ended scales (less than 0.5€ and more than 2€ mark the ends of our spectrum).

For both of these, measures of central tendency reveal additional information. However, since we coded the variables with numeric values in SPSS, in order to make an analysis possible, it is important to decipher the code again correctly.

For example, the most frequently recorded value for amount of consumption (mode) is 7, which is the last category, where energy drink consumption is lowest (seldom). Hence, the higher the value, the less often energy drinks are consumed. The median being 6 shows us that 50% of all respondents consume energy drinks once a month or less, whereas the mean is slightly closer to category 5 (many times a month). However, the mean is influenced by the extreme values in category 1 and 7, whereas mean and mode are not. The quartiles reveal that after cumulating 25% of respondents' answers, we are already down to a frequency of once per week or less, meaning 3 out of 4 participants drink no more than one energy drink every 7 days. The 50% quartile corresponds to the median and since category 7 is the most frequently reported, the 75% quartile "scoops up" the last category, completing the remainder of all observations.

		Amount	
		Consumption	Appropriate Price
N	Gültig	678	679
	Fehlend	117	116
Mittelwert		5,37	2,79
Median		6,00	3,00
Modus		7	3
Perzentile	25	4,00	2,00
	50	6,00	3,00
	75	7,00	3,00

### Fig. 11: Measures of central tendency for amount of consumption and appropriate prices of energy drinks

The variable for appropriate price has been coded in a similar fashion, except that a bigger category number corresponds to a higher price, not a lower one. Due to the heavy concentration of observations around categories 2 and 3 (0.5 to  $1 \in$  and 1 to  $1.5 \in$ , respectively) with over 75% of answers, calculating means of central tendency does not reveal a lot of additional information. The 25% mark of all observations is crossed in category 2, with the jump to the next interval garnering the bulk of the remaining values, including the 50% and 75% quartiles (as well as the median, which corresponds to the 50% quartile). The mode is 3 and the average is fairly close to the most central category as well with 2.79. This tells us that less than 25% of all respondents consider prices above  $1.5 \in$  as fair.



#### **5. Descriptive Analysis**

This next section of the analysis deals with descriptive statistics. These measures will reveal how much the data is grouped around the center and how close it comes to a normal distribution. Analyzed measures include mean, variance, standard deviation, range, kurtosis and skewness.

#### **1.** Question 9: Appropriate price

Regarding appropriateness of energy drink prices, we previously discussed mean, median and mode. Since this is an interval variable coded ordinally, it does not make sense to calculate variance, standard deviation, skewness, kurtosis and range.

Since the categories are coded with values 1 to 5, calculating the range even gets us an inaccurate result - after all, there are 5 possible price intervals, not 4.

Kurtosis is negative, pointing at a flattened distribution, which is hard to verify visually. These measures do not make a lot of sense, due to the variable coding.

Appropriate Price							
Ν	Gültig	679					
	Fehlend	116					
Mittelwert		2,79					
Median		3,00					
Modus		3					
Standarda	,852						
Varianz		,726					
Schiefe		,251					
Kurtosis		-,311					
Spannweit	e	4					
Minimum		1					
Maximum		5					
Summe		1892					

#### Statistiken

Fig. 12: Descriptive statistics for appropriate prices of energy drinks

#### 2. Question 15: Intensity of brand changing

The same logic applies to the variable "Intensity of brand changing," which refers to how often people change their preferred brand of energy drinks. It is an ordinal variable, however, several problems occur when trying to interpret data like mean, variance, etc.

First, the categories are not balanced. Starting with "very often," which is an undefined number of brand changes (with no time interval tied to it), the scale ends at never, which equates to zero. The opposite would be "always," which is an impossible answer, in this case.

Second, the variable is coded the same way appropriate price is, yet an increasing value



indicates a lower frequency of brand change, which makes interpretation even trickier.

Third, the "intervals" of brand change the variable represents are ambiguous. "Very often," "Often," "Sometimes," etc. are not sufficiently detailed frequencies to make meaningful conclusions.

Hence, it makes no sense to compute descriptive statistics for this variable.

Absolute observations and a bar chart are included for completeness.

Statistiken					
Intensity Brand Changing					
N Gültig	678				
Fehlend	117				
Mittelwert	3,78				
Median	4,00				
Modus	4				
Standardabweichung	1,005				
Varianz	1,010				
Schiefe	-,608				
Standardfehler der Schiefe	,094				
Kurtosis	-,045				
Standardfehler der Kurtosis	,187				
Spannweite	4				
Minimum	1				
Maximum	5				
Summe	2560				

Fig. 13: Descriptive statistics for intensity of brand changing of energy drinks

Intensity Brand Changing							
		Häufigkeit	Prozent	Gültige Prozente	Kumulierte Prozente		
Gültig	Very often	18	2,3	2,7	2,7		
	Often	50	6,3	7,4	10,0		
	Sometimes	177	22,3	26,1	36,1		
	Rarely	254	31,9	37,5	73,6		
	Never	179	22,5	26,4	100,0		
	Gesamt	678	85,3	100,0			
Fehlend	System	117	14,7				
Gesamt		795	100,0				

Intonsity Brand Changin

Fig. 14: Frequency table for intensity of brand changing of energy drinks

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Fig. 15: Frequency bar chart for intensity of brand changing of energy drinks (with normal distribution curve)

#### 3. Question 20.1: Satisfaction with Drink 1

The level of satisfaction with respondents' preferred drink number 1 is measured on a 1 to 9 scale, which is ordinal and thus, also does not really hand itself to a descriptive analysis.

The most meaningful statistic to calculate is the Median. Mean and median are almost identical with 7.01 and 7, showing that 50% of the observations fell on the top three ratings. A look at the frequency table (and the Mode, which is 8) confirms this.



Statisfaction Drink 1								
				Gültige	Kumulierte			
		Häufigkeit	Prozent	Prozente	Prozente			
Gültig	Not at all	6	,8	,9	,9			
	2	11	1,4	1,6	2,5			
	3	14	1,8	2,1	4,6			
	4	13	1,6	1,9	6,6			
	5	49	6,2	7,3	13,9			
	6	113	14,2	16,8	30,7			
	7	173	21,8	25,8	56,5			
	8	177	22,3	26,4	82,9			
	A lot	115	14,5	17,1	100,0			
	Gesamt	671	84,4	100,0				
Fehlend	System	124	15,6					
Gesamt		795	100,0					

Fig. 16: Frequency table for satisfaction with drink 1 of preferred energy drinks

However, one has to be careful not to forget that an ordinal does not equal an interval variable. A person rating their satisfaction with 9 is not necessarily 3 times as happy with their energy drink of choice as a person rating their satisfaction with 3.

Statisfaction Drink 1						
Ν	Gültig	671				
	Fehlend	124				
Mittelwert		7,01				
Median		7,00				
Modus		8				
Standardab	weichung	1,629				
Varianz		2,654				
Schiefe		-1,179				
Standardfel	nler der Schiefe	,094				
Kurtosis		1,778				
Standardfel	nler der Kurtosis	,188				
Spannweite	•	8				
Minimum		1				
Maximum		9				
Summe		4707				

#### Statistiken

Fig. 17: Descriptive statistics for satisfaction with drink 1 of preferred energy drinks

Skewness is negative, indicating a left-skewed distribution, with the long tail of the data on the left and the majority of observations on the right, which is correct. Kurtosis is positive,



hinting at a peaked distribution, with heavy grouping around values 7 and 8.

A look at the bar chart with a plotted curve confirms this. On average, people are positively satisfied with their chosen energy drink number one.



Fig. 18: Frequency bar chart for satisfaction with drink 1 of preferred energy drinks (with normal distribution curve)

Computing the mean of satisfaction with drink 1 for genders separately reveals that on average, women are slightly less satisfied with their chosen drink than men.

Gruppenstatistiken								
				Standardabweichu	Standardfehler			
	Gender	N	Mittelwert	ng	des Mittelwertes			
Statisfaction Drink 1	Male	367	7,08	1,659	,087			
	Female	286	6,91	1,608	,095			

Fig. 19: Group statistics for satisfaction with drink 1 of preferred energy drinks for men and women

**Note**: At this point in the analysis, I realized several values in the final data set were coded in the wrong way. Absolute frequencies for satisfaction with drink 1 showed a total of 671 responses, whereas the total number of valid responses compared across genders yielded only 653 responses. Some were indeed missing values, but for 5 data points, the value for



gender was set to 0. Since this variable is coded in 1 for men and 2 for women, these 5 values were deleted to recode in missing values for further analysis. However, the bar chart shows the means to be very close to one another, making this an observation we have to be careful with stating how strong it actually is.



Fig. 20: Bar chart for average satisfaction with drink 1 of preferred energy drinks for men and women



In this sample, 30% more men than women gave their answers to this question.

Fig. 21: Bar chart for average satisfaction with drink 1 of preferred energy drinks for men and women



A good title could be: "Average satisfaction with preferred choice of energy drink across genders." An interesting question to ask would be "Are men more satisfied with their energy drink of choice than women?"

To answer this question, we can conduct a t-test to compare two means of independent samples (men and women are independent sub-samples).

Our null hypothesis H0 in this case is that the mean for satisfaction with energy drink 1 is the same for men and women - they are not different.

The t-test conducted with SPSS yields a 2-sided significance of 0.191 and a 1-sided significance level of 0.0955, which is not enough to reject the null hypothesis on a 5% significance level. Therefore, we cannot reject the hypothesis that average satisfaction with drink 1 is the same among men and women.

		Leve	ene-Test der							
Varianzgleichh eit					T-Test	für die l	Mittelwertaleichh	eit		
				Sig. (2- Mitt SE der der Differen:			95% enzintervall Differenz			
		F	Sig	Т	df	seitig)	Diff.	Differenz	Untere	Obere
Statisfacti on Drink 1	Varianzen sind gleich	,089	,765	1,310	651	,191	,169	,129	-,084	,423
	Varianzen sind nicht gleich			1,315	621,169	,189	,169	,129	-,083	,422

Fig. 22: T-test for independent samples for average satisfaction with drink 1 of preferred energy drinks for men and women

#### 6. Contingency Tables

Contingency tables are best used to measure relationships between categorical valuables, for example age of buyer and purchase price of a car or gender and type of pet.

Thanks to joint frequencies from the table, it is possible to infer how likely a person is to own a car with a certain price when he or she is in a certain age group, for example, as well. Additionally, contingency tables allow computing the likelihood of certain categories applying, given we already have certain other information, which is called conditional probability.

Furthermore, they serve as the basis of the chi-square test, which is used to determine whether two variables are statistically independent, and Cramer's V, which is a more



accurate measure of the same characteristic.

In this section, we will analyze the relationship between the variables "sex," which is dichotomous and nominal and "perceived effectiveness" (of energy drinks), which is ordinal.

#### 1. Question 7 & 29: Sex vs. Perceived Effectiveness

A total of 660 male and female respondents reported valid answers for perceived effectiveness of consumption, with 135 values missing.

Verarbeitete Falle							
	Fälle						
	Gültig		Fehlend		Gesamt		
	N	Prozent	Ν	Prozent	N	Prozent	
Perceived Effectiveness of Consumption * Gender	660	83,0%	135	17,0%	795	100,0%	

Fig. 23: Total number of respondents who gave valid answers to both perceived effectiveness of consumption and the gender question

The contingency table shows absolute and relative frequencies, as well as joint frequencies and marginal distributions for all categories. We can interpret the data row- and columnwise.

For example, out of both genders, 61.1% reported they perceive energy drinks to be effective when consumed. This figure is calculated based on the average of the relative share of all men, who chose this answer (62.3% of the 371 men, which equates to 231 absolute observations), and the relative share of women with the same answer (59.5% of all 289 respondents, which equates to 172). This in turn means 57.3% of all those in our study, who perceive energy drinks to be effective, are men, while 42.7% are women. A hypothesis we could state from this is that people, who perceive energy drinks to be effective, are more likely to be men than women.

Similarly, we can make statements about the likelihood of how someone perceives energy drink effectiveness, based on their gender. For example, since both frequencies of "they do not work" are similarly low for men and women, we can say that for this sample, about 1 in 20 people perceive energy drinks to not be effective, regardless of gender.

Since SPSS has already calculated conditional probabilities here, we do not need to divide absolute values by column or row totals to calculate them.

#### 



			Ger	nder	
			Male	Female	Gesamt
Perceived	They are effective	Anzahl	231 <sub>a</sub>	172 <sub>a</sub>	403
Effectiveness of		% innerhalb von Perceived Effectiveness of Consumption	57,3%	42,7%	100,0%
Consumption		% innerhalb von Gender	62,3%	59,5%	61,1%
		Korrigierte Residuen	,7	-,7	
	It is just a psychological	Anzahl	121 <sub>a</sub>	102 <sub>a</sub>	223
	matter The do not work	% innerhalb von Perceived Effectiveness of Consumption	54,3%	45,7%	100,0%
		% innerhalb von Gender	32,6%	35,3%	33,8%
		Korrigierte Residuen	-,7	,7	
		Anzahl	19 <sub>a</sub>	15 <sub>a</sub>	34
		% innerhalb von Perceived Effectiveness of Consumption	55,9%	44,1%	100,0%
		% innerhalb von Gender	5,1%	5,2%	5,2%
		Korrigierte Residuen	,0	,0	
Gesamt		Anzahl	371	289	660
		% innerhalb von Perceived Effectiveness of Consumption	56,2%	43,8%	100,0%
		% innerhalb von Gender	100,0%	100,0%	100,0%

#### Perceived Effectiveness of Consumption \* Gender Kreuztabelle

Jeder tiefgestellte Buchstabe gibt eine Teilmenge von Gender Kategorien an, deren Spaltenanteile sich auf dem ,05-Niveau nicht signifikant voneinander unterscheiden.

Fig. 24: Crosstabs for perceived effectiveness of energy drinks across men and women (absolute and relative values)

#### 1. Question 1 & 29: Sex vs. Screening Question

A total of 772 respondents reported valid answers for both gender and the screening question, both of which are binary, nominal variables.

	Fälle							
	Gültig		Fehlend		Gesamt			
	N	Prozent	N	Prozent	Ν	Prozent		
Filter question * Gender	772	97,1%	23	2,9%	795	100,0%		

Fig. 25: Total number of respondents who gave valid answers to both the screening question and the gender question

The contingency table must be computed as a basis for the chi-square test. Among those who said "Yes" (consuming energy drinks), men where the majority group, whereas among



those who said "No," women represented slightly over 50%. For both genders, over 80% of all survey participants responded "Yes" to the filter question. This high sample-population fit is a good indicator of the sampling method used (convenience sampling).

			Ger	nder	
			Male	Female	Gesamt
Filter question	Yes	Anzahl	370 <sub>a</sub>	285 <sub>a</sub>	655
		% innerhalb von Filter question	56,5%	43,5%	100,0%
		% innerhalb von Gender	87,1%	82,1%	84,8%
		Korrigierte Residuen		-1,9	
	No	Anzahl	55a	62 <sub>a</sub>	117
		% innerhalb von Filter question	47,0%	53,0%	100,0%
		% innerhalb von Gender	12,9%	17,9%	15,2%
		Korrigierte Residuen	-1,9	1,9	
Gesamt		Anzahl	425	347	772
		% innerhalb von Filter question	55,1%	44,9%	100,0%
		% innerhalb von Gender	100,0%	100,0%	100,0%

#### Filter question \* Gender Kreuztabelle

Jeder tiefgestellte Buchstabe gibt eine Teilmenge von Gender Kategorien an, deren

Spaltenanteile sich auf dem ,05-Niveau nicht signifikant voneinander unterscheiden.

Fig. 26: Crosstabs for answers to the screening question across men and women (absolute and relative values)

Since men are the dominant segment of our "energy drink drinkers," we could hypothesize that men are more likely to drink energy drinks than women.

The chi-square test is aimed at showing whether the two tested variables are statistically independent, meaning we are testing the assumption that gender does not influence whether someone drinks energy drinks, or not.

This is in line with the H0 hypothesis stating the opposite of what we as researchers want to prove.

Our null hypothesis H0 is thus "gender has no impact on whether a person drinks energy drinks or not." Our alternative hypothesis, H1, becomes the opposite: "gender has an effect on whether a person consumes energy drinks."



The chi-square test yields a chi-square value of 3.605, which corresponds to an asymptotic significance value of 0.058, meaning we cannot reject the null hypothesis at a 5% significance level.

Chi-Quadrat-Tests								
			Asymptotische Signifikanz	Exakte Signifikanz (2-	Exakte Signifikanz (1-			
	Wert	df	(zweiseitig)	seitig)	seitig)			
Chi-Quadrat nach Pearson	3,605 <sup>a</sup>	1	,058					
Kontinuitätskorrektur <sup>b</sup>	3,232	1	,072					
Likelihood-Quotient	3,586	1	,058					
Exakter Test nach Fisher				,069	,036			
Zusammenhang linear-mit-	3 601	1	058					
linear	3,001	1	,038					
Anzahl der gültigen Fälle	772							

a. 0 Zellen (0,0%) haben eine erwartete Häufigkeit kleiner 5. Die minimale erwartete Häufigkeit ist 52,59.

b. Wird nur für eine 2x2-Tabelle berechnet

Fig. 27: Chi-square-test for independent samples for likelihood of consuming energy drinks for men and women

The table of symmetric measures confirms this, with Pearson's R and the Spearman correlation coefficient showing the same significance value. Thus, we cannot reject the hypothesis that gender has no impact on whether someone consumes energy drinks at a 5% significance level.

Symmetrische Maße								
			Asymptotischer	Näherungsweises	Näherungsweise			
		Wert	standardisierter Fehler <sup>a</sup>	ť	Signifikanz			
Intervall- bzgl.	Pearson-R	069	026	1 001	058 <sup>c</sup>			
Intervallmaß		,000	,030	1,901	oCU,			
Ordinal- bzgl.	Korrelation nach	069	026	1 001	058 <sup>0</sup>			
Ordinalmaß	Spearman	,068	,036	1,901	,058			
Anzahl der gültige	n Fälle	772						

a. Die Null-Hyphothese wird nicht angenommen.

b. Unter Annahme der Null-Hyphothese wird der asymptotische Standardfehler verwendet.

c. Basierend auf normaler Näherung

Fig. 28: Correlation table for screening question and gender

# **7.** Inferential Statistics - Comparing Sample Parameters to Specific Values

Now we turn to inferential statistics, which is the practice of estimating features of the population that is the aim of our research by analyzing the data we have collected from our sample.

There is a variety of testing methods we can use, and the choice of method depends on the



type and number of samples examined, as well as the level of measurement of the dependent variable. To determine the correct test, we can use a diagram listing all available methods and their use cases.

#### Diagram: "When To Use Which Statistical Test"

Measurement Level	One sample	Independe	ent samples	Related samples		
Dependent variable	k=1	k=2	k>2	k=2	k>2	
Interval/Ratio	t-test (mean)1	t-test (means) <sup>2</sup>	ANOVA (means) <sup>3</sup>	t-test (paired)	ANOVA (repeated measurement)	
SPSS: Compare Means	One-Sample T Test	Independent-Samples T Test	One-Way ANOVA	Paired-Samples T Test	General Linear Model > Repeated Measures	
Ordinal	Kolmogorov-Smirnov	Mann-Whitney U-test	Kruskal-Wallis test	-Wilcoxon test -Sign test	Friedman test	
SPSS: Nonparametric Tests	1-Sample K-S* (by hand	2 Independent Samples	K Independent Samples	2 Related Samples	K Related Samples	
Nominal						
Multiple Choice	Chi-square (one sample)	Chi-square (cross tabs)	Chi-square (cross-tabs)			
SPSS	Nonparametric Tests Chi-Square (or by hand)	Descriptive Statistics Crosstabs	Descriptive Statistics Crosstabs			
Dichotomy	z-test (proportion)	z-test (proportions)	Chi-square (cross-tabs)			
SPSS	by hand	by hand	Descriptive Statistics Crosstabs			

Fig. 29: Diagram of statistical tests, depending on level of measurement of dependent variable and type and number of samples

#### **1. One Sample Tests**

We will start with one sample tests, where we compare the parameter of a sample group against a fixed value. These tests reveal, in part, how representative our sample is of the population we are looking to examine.

#### 1. Question 10.2: Is the average importance of "Brand" equal to 4.5?

To find out if the population mean of brand importance is 4.5, we can can use the onesample t-test of the mean, which corresponds to the top left section of the diagram: comparing a ratio variable (Likert scale) from one sample.

The average value for brand importance in our sample is 5.37.

			Standardabweic	Standardfehler				
	Ν	Mittelwert	hung	des Mittelwertes				
Brand	677	5,37	4,644	,178				

#### Statistik bei einer Stichprobe

Fig. 30: Total number of respondents who gave valid answers to importance of brand question

We want to know if the population mean is exactly 4.5, so our H0 becomes "The mean of brand importance equals to 4.5," assuming the two are not different. H1 would then be "the mean of brand importance does not equal 4.5."



The t-test results in a test statistic of 4.862, with a very low p-value, indiciating high significance. Thus, we can reject the null hypothesis on a 5% significance level. We have evidence to believe the population mean for brand importance is different from 4.5.

	Testwert = 4.5								
					95% Konfidenzintervall der				
				Mittlere	Differenz				
	Т	df	Sig. (2-seitig)	Differenz	Untere	Obere			
Brand	4,862	676	,000	,868	,52	1,22			

#### Test bei einer Sichprobe

Fig. 31: T-test for the mean of one sample for average importance of brand

### 2. Question 10.1: Is the average importance of "Benefits" equal to 7?

This test is performed exactly like the previous one, because importance of benefits is measured with a Likert scale as well. The average value of importance for benefits in our sample is 6.81.

#### Statistik bei einer Stichprobe

			Standardabweic	Standardfehler
	Ν	Mittelwert	hung	des Mittelwertes
Benefits	677	6,81	2,091	.080

Fig. 32: Total number of respondents who gave valid answers to importance of benefits question

Our H0 is "The average importance of benefits is equal to 7" with the corresponding H1 "the average importance of benefits does not equal 7."

The resulting test statistic is -2.353, indicating that our sample mean is smaller than the hypothesized value, which is correct (6.81 < 7). The p-value can then be used to determine the significance of this observation. It is 0.019, or 1.9%, which means we can again reject the null hypothesis at a 5% significance level (p < 0.05). Our analysis indicates that the average importance of benefits is not equal to 7.



#### Test bei einer Sichprobe

	Testwert = 7							
					95% Konfidenzintervall der			
				Mittlere	Differenz			
	Т	df	Sig. (2-seitig)	Differenz	Untere	Obere		
Benefits	-2,353	676	,019	-,189	-,35	-,03		

Fig. 33: T-test for the mean of one sample for average importance of benefits

It must be noted that a significant difference is not automatically substantive. Here, the average difference from 7 is -0.189 - but how does that translate to the perceived importance in respondents? Can they make out the difference between valuing importance of benefits at 7 or 6.811? And what do both of those translate to in absolute importance?

Significance depends on the magnitude of the difference and the sample size. A smaller difference is more meaningful in a large sample than in a small one.

How relevant this significant difference is is hard to say here, especially since the measured variable is highly subjective.

#### 3. Question 29: Is the proportion of men in the sample equal to 50%?

Out of 773 valid responses to the gender question, 425 were from male participants, making them a 55% proportion in our sample.

Gender										
				Gültige	Kumulierte					
		Häufigkeit	Prozent	Prozente	Prozente					
Gültig	Male	425	53,5	55,0	55,0					
	Female	348	43,8	45,0	100,0					
	Gesamt	773	97,2	100,0						
Fehlend	System	22	2,8							
Gesamt		795	100,0							

Fig. 34: Frequency table for proportions of men and women in the sample (absolute and relative)

Now we want to infer whether we can expect the proportion of men in the population to be 50%, based on this drawn sample. Since respondents can only be male or female, this is a dichotomous, nominal variable, meaning we have to calculate a z-test for the proportion by hand (bottom left corner of the diagram).

To do so, we can use the following formula:





Fig. 35: Z-test formula one sample with a dichotomous dependent variable

Our H0 is that the proportion of men is equal to 50%, H1 is that it is not equal to 50%. We have to calculate the standard deviation of the population (an estimate), for which we need sample size, the test value we are comparing our sample values to (50%) and the proportion in the sample (55%).

First, we calculate sigma, which is 0.018.

$$\sigma_p = \sqrt{\frac{0.5(1-0.5)}{773}} = 0.018$$

Fig. 36: Sigma calculation for z-test for proportion of men

Then, we substitute the values into the z-equation to obtain the z-value of 2.78.

$$z = \frac{0.55 - 0.5}{0.018} = 2.78$$

Fig. 37: Z-test calculation for proportion of men

This is a 2-sided z-test, since for our H1 it does not matter whether the proportion is bigger or smaller than 50% - as long as it is different one way or the other on a significant level, we will reject H0.

To confirm our test done by hand, we can use <u>the MedCalc z-test calculator</u>, which yields the same result and also gives us the p-value of 0.0054, which indicates significance at a 5% level.

z = 2.780	
Significance level	P = 0.0054
95% CI of observed proportion	51.41 to 58.55

Fig. 38: Z-test results for proportion of men



For 2-tailed z-test, the z-value corresponding to a 5% significance level is 1.96. If our calculated z-value is higher, we can reject the null hypothesis. Since 2.78 > 1.96, we can reject the null hypothesis at the 5% significance level. We believe the proportion of men in the population is not 50%.

#### 2. Independent and Related Sample Tests

When comparing values across different groups or variables, we have to distinguish between independent and related samples. Independent samples are used to compare observations of a single parameter (like perceived effectiveness) across different groups (men and women, for example). Related samples are used to compare responses to different questions from the same group, for example if women like their energy drink number 1 as much as number 2.

### 1. Question 20.1 & 29: Are women just as satisfied with their number 1 energy drink as men?

Since we want to compare the observations of one parameter (satisfaction with drink 1, ratio scale) for two independent groups (men and women, dichotomous nominal scale) here, we can compute an independent samples t-test with SPSS.

Our null hypothesis H0 is that women are just as (or more) satisfied with their number 1 energy drink as men. H1 then becomes that women are less satisfied with their number 1 energy drink than men. In our sample, average satisfaction with drink 1 is 7.08 for men and 6.91 for women.

Gruppenstätistiken										
				Standardabweic	Standardfehler					
	Gender	N	Mittelwert	hung	des Mittelwertes					
Statisfaction Drink 1	Male	367	7,08	1,659	,087					
	Female	286	6,91	1,608	,095					

Fig. 39: Group statistics for satisfaction with drink 1 across men and women

This is a 1-sided t-test, since we only accept evidence for women being equally satisfied or more, not less. We are not testing just a difference, but a difference in a certain direction.

The t-test in SPSS shows a 2-sided significance level of 0.191. This value must be divided by 2, in order to obtain the 1-sided significance level. This is 0.0955, which is still higher than 0.05. Therefore, we cannot reject H0 at a 5% significance level and remain with the hypothesis that women are equally as satisfied with drink 1 as men.



Test bei unabhängigen S	tichproben
-------------------------	------------

		Levene- Varianzg	Test der leichheit		т	-Test für di	ie Mittelwer	tgleichh	eit	
								SF der	9 Konfidei	5% nzintervall
						Sig.	Mittlere	Differ	der D	ifferenz
		F	Sig	Т	df	(2-seitig)	Differenz	enz	Untere	Obere
Statisfaction Drink 1	Varianzen sind gleich	,089	,765	1,310	651	,191	,169	,129	-,084	,423
	Varianzen sind nicht aleich			1,315	621,169	,189	,169	,129	-,083	,422

Fig. 40: T-test for independent samples for satisfaction with drink 1 across men and women

### 2. Question 20.1 & 20.2: Are people more satisfied with their number 1 energy drink than their number 2 energy drink?

Now we want to learn something about responses to different questions from the same people, namely if their satisfaction with drink 1 and 2 differs. The dependent variable is interval scaled (1 to 9), thus we can conduct a paired t-test in SPSS.

A null hypothesis implies that there is no effect or correlation between two variables, so now our H0 is that people are *not* more satisfied with drink 1 than drink 2. Then we can try to find significant evidence against this, which is in favor of H1: "People are more satisfied with their number 1 energy drink than their number 2 energy drink."

To conduct the test, we first have to obtain average satisfaction with both drinks from our sample, which is 7.09 for drink 1 and 6.09 for drink 2.

Statistik bei gepaarten Stichproben									
					Standardfehler des				
		Mittelwert	Ν	Standardabweichung	Mittelwertes				
Paaren 1	Statisfaction Drink 1	7,09	566	1,609	,068				
	Satisfaction Drink 2	6.09	566	1.915	.080				

Fig. 41: Descriptive statistics for satisfaction with drink 1 and 2

Then we can calculate the correlation among the two satisfaction level, which has an R value of 0.339 and is highly significant.

Korrelationen bei gepaarten S	Stichproben
-------------------------------	-------------

		N	Korrelation	Signifikanz
Paaren 1 Statisfaction Drink 1 &	500	000	000	
	Satisfaction Drink 2	566	,339	,000

Fig. 42: Correlation for satisfaction with drink 1 and 2



Then, the test statistic can be calculated. The table shows a significant difference with an average value of about 1 (0.996), indicating that on average, people are more satisfied with drink 1 by 1 unit as compared to drink 2. Thus, we can reject H0 on a 5% significance level and conclude that people are indeed more satisfied with drink 1 than drink 2.

				Standardfehler des	95% Konfidenzintervall der Differenz				Sig.
		Mittelwert	Stabw.	Mittelwertes	Untere	Obere	Т	df	(2-seitig)
Paar 1	Statisfaction Drink 1 - Satisfaction Drink 2	,996	2,041	,086	,828	1,165	11,614	565	,000

#### Test bei gepaarten Stichproben

Fig. 43: Paired t-test for related samples for satisfaction with drink 1 and 2

### 3. Question 10.2 & 33: Do people with a different education level put a different average importance on the attribute "brand?"

This is another independent sample test, since the different education groups are distinct from one another. People can only have one "highest level of education" out of several categories. Importance of brand is interval scaled, while education level is ordinal. However, we have more than two independent samples here, because there are 3 different categories for highest education level (High-School, Bachelor's Degree, Master's Degree).

Therefore, we must conduct a one-way ANOVA test in SPSS. H0 is that importance is not valued differently across various education levels, H1 is that people with different education levels will perceive the brand as more or less important depending on their level. Average values for importance across the different groups range from 5.11 to 5.59 in our sample.

ыяна								
					95%-Konfidenzintervall für			
		Mittei-	Standard-	Standard-		Illeiweit		
	Ν	wert	abweichung	fehler	Untergrenze	Obergrenze	Minimum	Maximum
High-school	153	5,11	2,255	,182	4,75	5,47	1	9
Bachelor's	381	5.39	5.819	.298	4.81	5.98	-99	9
degree		0,00	0,010	,	.,0 .	0,00		, i i i i i i i i i i i i i i i i i i i
Master's	140	5 50	2 561	216	5 16	6.01	1	0
degree	140	5,59	2,501	,210	5,10	0,01	1	9
Gesamt	674	5,37	4,653	,179	5,02	5,72	-99	9

#### **ONEWAY deskriptive Statistiken**

Drand

Fig. 44: Descriptive statistics for importance of brand across different education levels

The following one-way ANOVA reveals that there is no statistically significant difference between the different groups. The p-value is 0.676, which is not less than 0.05 and thus we cannot reject H0. We cannot validate a significant difference in average importance of the



attribute brand across groups.

#### Einfaktorielle ANOVA

Brand

	Quadratsumme	df	Mittel der Quadrate	F	Signifikanz
Zwischen den Gruppen	16,983	2	8,491	,392	,676
Innerhalb der Gruppen	14552,027	671	21,687		
Gesamt	14569,010	673			

Fig. 45: One-way ANOVA test for means of independent samples for importance of brand across different education levels

### 4. Question 29 & 33: Is the education of respondents distributed equally across genders?

Whether gender has an impact on education is another independent samples test, since men and women are distinct groups. The dependent variable education could be considered as ordinal for various reasons (duration of education, average salary, etc.) but since we cannot draw definite conclusions about which level of education is "better," it is treated as nominal here.

This makes the appropriate test a chi-square test using crosstabs (contingency tables) for 2 independent samples.

Our H0 is that gender does not influence education whatsoever, and that it is equally distributed across groups. H1 is that gender affects level of education.

A total of 769 respondents have reported valid values for both education and gender.

	Fälle									
	Gültig		Feh	lend	Gesamt					
	N	Prozent	N	Prozent	N	Prozent				
Education * Gender	769	96,7%	26	3,3%	795	100,0%				

Verarbeitete Fälle

Fig. 46: Total number of respondents who gave valid answers to education level and the gender question

The crosstab shows that, in our sample, men represent the majority of high school certificate holders with 55% of all responses in those category. Bachelor degrees are spread almost evenly among men and women, while 65% of all Master's degree holders are men.



			Ger	nder	
			Male	Female	Gesamt
Education	High-school	Anzahl	91	73	164
		% der Gesamtzahl	11,8%	9,5%	21,3%
	Bachelor's degree	Anzahl	216	211	427
		% der Gesamtzahl	28,1%	27,4%	55,5%
	Master's degree	Anzahl	116	62	178
		% der Gesamtzahl	15,1%	8,1%	23,1%
Gesamt		Anzahl	423	346	769
		% der Gesamtzahl	55,0%	45,0%	100,0%

#### **Education \* Gender Kreuztabelle**

Fig. 47: Crosstabs for levels of education across genders

Computing the chi-square test with 2 degrees of freedom (always one less than dependent variable categories) generates a chi-square value ov 10.815 at a p-value of 0.004. The critical test statistic value for a chi-square test with 2 degrees of freedom is 5.99 at a 5% significance level (taken from <u>here</u>). Since our test statistic is higher and significance criteria are matched, we can reject H0 and say that gender does indeed influence level of education.

Chi-Quadrat-Tests						
			Asymptotische Signifikanz			
	Wert	df	(zweiseitig)			
Chi-Quadrat nach Pearson	10,815 <sup>a</sup>	2	,004			
Likelihood-Quotient	10,958	2	,004			
Zusammenhang linear-mit- linear	3,534	1	,060			
Anzahl der gültigen Fälle	769					

a. 0 Zellen (0,0%) haben eine erwartete Häufigkeit kleiner 5. Die

minimale erwartete Häufigkeit ist 73,79.

Fig. 48: Chi-square test for independent samples for impact of gender on level of education

However, the measured correlation between gender and level of education is weak, being in the (-)0.01-0.1 range. It is also not highly significant, as the table of symmetric measures shows (neither below 0.05 significance level for interval nor ordinal measure of the variable).



			Asymptotischer standardisierter	Näherungsweises	Näherungsweise
		Wert	Fehler	t~	Signifikanz
Intervall- bzgl. Intervallmaß	Pearson-R	-,068	,036	-1,883	,060 <sup>c</sup>
Ordinal- bzgl. Ordinalmaß	Korrelation nach Spearman	-,069	,036	-1,906	,057 <sup>c</sup>
Anzahl der gültigen Fälle		769			

#### Symmetrische Maße

a. Die Null-Hyphothese wird nicht angenommen.

b. Unter Annahme der Null-Hyphothese wird der asymptotische Standardfehler verwendet.

c. Basierend auf normaler Näherung

Fig. 49: Correlation table for education and gender

#### 5. Question 29 & 33: Do more men have a Master's degree than women?

Now we want to investigate whether someone, who has a Master's degree is more likely to be male than female. In this case, "has a Master's degree" is a condition we set before conducting the test, making this a "one sample" test for a dichotomous, nominal variable (meaning the dependent variable is whether someone is male or female, given they have a Master's degree).

Therefore, our H0 becomes: "Men are less or equally as likely to have a Master's degree as women." The according H1 is "Men are more likely to have a Master's degree than women."

To test this, we create a dummy variable, named "Education=Master's degree," which assigns a value of 1 to anyone who owns a Master's degree (value of education = 3) and a value of 0 to everyone else.

In our sample, 178 people have Master's degree, 116 of which are male, 62 of which are female. This means almost twice as many men hold a Master's degree as women.

Education=Master's degree * Gender Kreuztabelle							
			Ger	nder			
			Male	Female	Gesamt		
Education=Master's degree	,00	Anzahl	307	284	591		
		% der Gesamtzahl	39,9%	36,9%	76,9%		
	1,00	Anzahl	116	62	178		
		% der Gesamtzahl	15,1%	8,1%	23,1%		
Gesamt		Anzahl	423	346	769		
		% der Gesamtzahl	55,0%	45,0%	100,0%		

Fig. 50: Crosstabs for distribution of Master's degrees across men and women



The bar chart represents this visually. Consider only the right side, as those are Master's degree holders.



Fig. 51: Bar chart for distribution of Master's degrees across men and women

Using the z-test formula from section 7.3 for one sample (since we only consider people, who have a Master's degree) with a dichotomous dependent variable (are Master degree holders men or women?), we can test the hypothesis.

Given H0, our test value outside the sample is 0.5 (which would indicate not more men than women have a Master's degree). With a sample size of 178, we can estimate the population standard deviation (sigma) to 0.037.

Plugging this into our z-test formula, we substract the test value from the observed proportion of male Master's degree holders in our sample (0.65), divide by sigma and attain a z-value of 4.04, which is higher than the one-sided z-test value 1.645 (since we are only interested in whether less men have a Master's degree than women, not less or more).

Thus, we can reject the null hypothesis at a significance level of 5%. Our conclusion is that men are indeed more likely to have a Master's degree than women.



### 6. Question 20.1 & 20.1: Is there a correlation between satisfaction with drink 1 and satisfaction with drink 2?

Now we want to find out if two variables are correlated to one another. For example, it could be that someone, who reports a higher satisfaction with drink 1, also reports a higher satisfaction with drink 2 (an example of a positive correlation).

A look at the descriptive statistics shows that average satisfaction with drink 1 is slightly higher in our sample than with drink 2 (7.01 vs. 6.09).

Deskriptive Statistiken							
		Standardabweic					
	Mittelwert	hung	Ν				
Statisfaction Drink 1	7,01	1,629	671				
Satisfaction Drink 2	6,09	1,915	566				

Fig. 52: Descriptive statistics for satisfaction with drink 1 and 2

Our H0 in this case is that the two variables are not correlated. H1 is that reporting a high satisfaction with drink 1 leads to a higher likelihood of reporting high satistfaction with drink 2 and the other way around.

Computing the correlation table gives us a Pearson's R of 0.339, which is considered evidence of a strong association (0.30-0.99). The correlation is also significant, at a 1% significance level even. Since R is positive, it indicates that people who report high values for satisfaction with drink 1 will also report high levels of satisfaction with drink 2 and vice versa.

	Korrelationen		
		Statisfaction	Satisfaction
		DINKI	DHHK Z
Statisfaction Drink 1	Korrelation nach Pearson	1	,339**
	Signifikanz (2-seitig)		,000
	Quadratsummen und Kreuzprodukte	1777,851	590,224
	Kovarianz	2,654	1,045
	Ν	671	566
Satisfaction Drink 2	Korrelation nach Pearson	,339**	1
	Signifikanz (2-seitig)	,000	
	Quadratsummen und	500 224	2072 027
	Kreuzprodukte	590,224	2072,037
	Kovarianz	1,045	3,667
	Ν	566	566

\*\*. Die Korrelation ist auf dem Niveau von 0,01 (2-seitig) signifikant.

Fig. 53: Correlation table for satisfaction with drink 1 and 2



# 7. Question 18.1 & 9: Is there a correlation between drink 1 providing the intended benefits and what price is considered appropriate?

Lastly, we'd like to know if someone, who observes the benefits they'd like to get from consuming energy drinks, is considering a higher price as more appropriate (and thus willing to pay more), or if people who consider higher prices as okay believe their energy drinks to benefit them more (a correlation goes both ways).

H0 in this case is there is no correlation between perceiving benefits as stronger and considering a higher price as appropriate (or vice versa). H1 then indicates that reporting higher perceived benefits makes it likelier to also report higher prices as appropriate.

Descriptive statistics show averages for both values at 2.79 for appropriate price (which corresponds to the  $1 \in 1.50 \in \text{level}$ ) and average level of benefits perceived at 7.02.

Deskiptive Statistiken							
		Standardabweic					
	Mittelwert	hung	Ν				
Appropriate Price	2,79	,852	679				
Benefits	7,02	2,014	672				

Deskriptive Statistiken

Fig. 54: Descriptive statistics for observation of desired benefits and appropriateness of prices of energy drinks

The correlation table reveals a significant (at the 1% level even) correlation, albeit a weak one. We can reject the null hypothesis. Therefore, a higher level of what people think is an appropriate price has an impact on how much they observe the benefits they desire from an energy drink (and vice versa).

		Appropriate Price	Benefits
Appropriate Price	Korrelation nach Pearson	1	,134 <sup>**</sup>
	Signifikanz (2-seitig)		,000
	Quadratsummen und Kreuzprodukte	492,035	154,786
	Kovarianz	,726	,231
	Ν	679	672
Benefits	Korrelation nach Pearson	,134**	1
	Signifikanz (2-seitig)	,000	
	Quadratsummen und Kreuzprodukte	154,786	2722,749
	Kovarianz	,231	4,058
	Ν	672	672

Korrelationen

\*\*. Die Korrelation ist auf dem Niveau von 0,01 (2-seitig) signifikant.

Fig. 55: Correlation table for observation of desired benefits and appropriateness of price



#### 8. Factor Analysis - Principal Components, Varimax Rotation

A factor analysis serves the purpose of uncovering latent (hidden) variables in a data set, which may influence several other variables.

Psychological constructs, such as ethnicity, materialism or introversion are hard to measure with singular questions, as answers are subjective. To get a more granular picture, it can help to ask more questions about subtle questions, which target sub-features of the more complex concept. For example "How often do you go out on weekends?" and "How likely are you to ask a stranger for directions in public?" find out more about introversion in various situations, and can be part of a larger set of questions, which is later subjected to a factor analysis.

A factor analysis lets us find a smaller set of variables, which explain most of the variance in the data set for all the actually measured ones. In this study, we will conduct an exploratory factor analysis, which is used to learn more about a data set. It is a principal component analysis, using a varimax rotation, as we expect the resulting factors to be independent.

The analyzed question battery is for question 18, which asks for the importance of several attributes of respondents' preferred drink number 1. If the analysis is successful, we can group several variables together in a fewer number of factors and then say participants consider these factors as important, when choosing their preferred brand of energy drink.

#### 1. Kaiser-Meyer-Olkin criterion & Bartlett's test

Before performing a factor analysis, it's important to analyze whether a factor analysis makes sense for the given data set. For this, the variables have to be correlated, but not too much (no multi-collinearity or singularity, which is very high or perfect correlation).

To measure this, we can use the Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity.

The first output we receive from SPSS is the correlation matrix for all variables. Scanning this for correlation coefficients higher than 0.9 and significance values >0.05 shows us variables, which we should consider eliminating from the analysis. Only the significance of brand is slightly over this limit. All other values look good.

		Benefits	Brand	Packaging	Availability	Price	Variety	Taste	Healthiness	Sparkling	Freshness	Color	Calories	Digest
Korr.	Benefits	1,000	,285	,291	,420	,197	,151	,336	,087	,244	,333	,116	,160	,225
	Brand	,285	1,000	,492	,382	,061	,229	,113	,091	,221	,203	,297	,137	,265
	Packaging	,291	,492	1,000	,388	,161	,349	,235	,199	,305	,340	,442	,284	,387
	Availability	,420	,382	,388	1,000	,313	,227	,324	,089	,200	,332	,206	,167	,247
	Price	,197	,061	,161	,313	1,000	,254	,192	,232	,099	,159	,186	,234	,211
	Variety	,151	,229	,349	,227	,254	1,000	,176	,307	,283	,237	,298	,390	,351
	Taste	,336	,113	,235	,324	,192	,176	1,000	,085	,330	,474	,239	,166	,214
	Healthiness	,087	,091	,199	,089	,232	,307	,085	1,000	,122	,273	,283	,508	,417
	Sparkling	,244	,221	,305	,200	,099	,283	,330	,122	1,000	,574	,348	,253	,320
	Freshness	,333	,203	,340	,332	,159	,237	,474	,273	,574	1,000	,350	,317	,396
	Color	,116	,297	,442	,206	,186	,298	,239	,283	,348	,350	1,000	,374	,440
	Calories	,160	,137	,284	,167	,234	,390	,166	,508	,253	,317	,374	1,000	,547
	Digest	,225	,265	,387	,247	,211	,351	,214	,417	,320	,396	,440	,547	1,000
Sig. (1-seitig)	Benefits		,000	,000	,000	,000	,000	,000	,012	,000	,000	,001	,000	,000
	Brand	,000		,000	,000	, <mark>056</mark>	,000	,002	,009	,000	,000	,000	,000	,000
	Packaging	,000	,000		,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	Availability	,000	,000	,000		,000	,000	,000	,011	,000	,000	,000	,000	,000
	Price	,000	,056	,000	,000		,000	,000	,000	,005	,000	,000	,000	,000
	Variety	,000	,000	,000	,000	,000		,000	,000	,000	,000	,000	,000	,000
	Taste	,000	,002	,000	,000	,000	,000		,014	,000	,000	,000	,000	,000
	Healthiness	,012	,009	,000	,011	,000	,000	,014		,001	,000	,000	,000	,000
	Sparkling	,000	,000	,000	,000	,005	,000	,000	,001		,000	,000	,000	,000
	Freshness	,000	,000	,000	,000	,000	,000	,000	,000	,000		,000	,000	,000
	Color	,001	,000	,000	,000	,000	,000	,000	,000	,000	,000		,000	,000
	Calories	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000		,000
	Digest	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	

a. Determinante = ,026 Fig. 56: Coefficient matrix for factor analysis



Now we can compute the KMO-value and Bartlett's test. The KMO value is 0.842. The test is considered as passed for values of 0.5 and higher, which means according to the KMO test, the data set is fit for a factor analysis. The resulting factors should be reliable and sufficiently different from one another.

Bartlett's test tries to reject the H0 hypothesis that the correlation matrix is really an identity matrix, in which all correlation coefficients are zero, meaning the variables would all be independent and thus also not suitable for a factor analysis. The test is significant (p < 0.001), which means we can reject this null hypothesis and continue with our factor analysis.

n		
Maß der Stichprobeneignung n	,842	
Bartlett-Test auf Sphärizität	Ungefähres Chi-Quadrat	2420,509
	df	78
	Signifikanz nach Bartlett	,000
		,000

KMO- und Bartlett-Test

Fig. 57: Kaiser-Meyer-Olkin criterion and Bartlett test for factor analysis

#### **2.** Number of extracted factors based on Screeplot and Eigenvalues

Next, we can look at the computed Screeplot and Eigenvalue table, in order to determine how many factors we should extract from our data set. All factors with an Eigenvalue >1 will be extracted, as the variables belonging to these explain most of the variance of the data set. The Screeplot shows the Eigenvalues of the factors in decreasing order, meaning where the slope of the curve flattens is where we should stop our extraction process. In this case, the curve flattens after factor number 4.



Fig. 58: Screeplot for factor eigenvalues



The table of Eigenvalues and explained total variance confirms this. It shows us that the first 4 factors have Eigenvalues >1. Combined, they explain 62.52% of the total variance in the data for this question. This table also shows the squared and rotated sums of the factor loadings, rotated being the final solution, where relative importance of all four factors has been equalized, but total explained variance remains the same.

				Summen von quadrierten			Rotierte Summe der			
	Anfär	ngliche Eig	genwerte	Faktorla	dungen fü	r Extraktion	quadrierten Ladungen			
		% der	Kumulierte		% der	Kumulierte		% der	Kumulierte	
Komponente	Gesamt	Varianz	%	Gesamt	Varianz	%	Gesamt	Varianz	%	
1	4,334	33,336	33,336	4,334	33,336	33,336	2,558	19,678	19,678	
2	1,528	11,756	45,092	1,528	11,756	45,092	2,077	15,979	35,658	
3	1,165	8,965	54,056	1,165	8,965	54,056	1,895	14,576	50,233	
4	1,101	8,466	62,522	1,101	8,466	62,522	1,598	12,289	62,522	
5	,785	6,038	68,560							
6	,705	5,424	73,984							
7	,614	4,723	78,707							
8	,559	4,302	83,009							
9	,528	4,059	87,068							
10	,467	3,591	90,658							
11	,455	3,500	94,159							
12	,419	3,223	97,382							
13	,340	2,618	100,000							

	_
Erklärte	Gesamtvarianz

Extraktionsmethode: Hauptkomponentenanalyse.

Fig. 59: Eigenvalues and proportion of total variance explained for squared and rotated factors

#### 3. Question, for which the highest proportion of total variance is explained

Another output we receive from SPSS is the table of communalities. This shows us how much of the variance in a given variable (in this case question) is common to the extracted factors. Here, it is highest for the attribute "brand", followed very closely by "freshness". The value of 0.742 means 74.2% of the variance around the importance of brand is explained by our 4 chosen factors.

# ТUП

Kommunalitäten					
	Anfänglich	Extraktion			
Benefits	1,000	, <u>541</u>			
Brand	1,000	, <mark>742</mark>			
Packaging	1,000	,664			
Availability	1,000	,674			
Price	1,000	,670			
Variety	1,000	,415			
Taste	1,000	,628			
Healthiness	1,000	,615			
Sparkling	1,000	,666			
Freshness	1,000	,734			
Color	1,000	,526			
Calories	1,000	,660			
Digest	1,000	,592			

Extraktionsmethode: Hauptkomponentenanalyse. Fig. 60: Table of communalities

#### 4. Factor loading and chosen factor of "brand"

After deciding how many factors to extract, we can now look at the component matrix and rotated component matrix to see how we should allocate our variables to each of the 4 factors. According to Hair et.al. (1998, pg. 111), only factor loadings of ±0.5 are "Practically Significant" and are thus the most expressive, so we will only interpret those in our analysis.

Unless factor loadings are very close to one another, variables should be allocated to the factor for which they have the highest factor loading.

For example, looking at the rotated component matrix with all loadings (no values cut off), we can see that the variable "brand" has a 0.848 loading for factor 3, and very little loadings for the other factors (0.035-0.137). This means we should allocate it to factor 3.

# ТЛП

	Komponente			
	1	2	3	4
Calories	,791	,160	,062	,070
Healthiness	,778	,023	-,053	,077
Digest	,666	,268	,272	,060
Variety	,554	,084	,263	,177
Color	,491	,316	,421	-,086
Freshness	,259	,793	,119	,152
Sparkling	,187	,765	,205	-,061
Taste	,029	,685	-,023	,397
Brand	,054	,035	, <mark>848</mark>	,137
Packaging	,277	,197	,726	,150
Price	,386	-,063	-,117	,709
Availability	,037	,177	,429	,676
Benefits	-,035	,337	,261	,599

#### Rotierte Komponentenmatrix<sup>a</sup>

Extraktionsmethode: Hauptkomponentenanalyse.

Rotationsmethode: Varimax mit Kaiser-Normalisierung.

a. Die Rotation ist in 9 Iterationen konvergiert.

Fig. 61: Rotated component matrix for factor analysis with all values (no cutoff value specified)

We will later see that this factor consists of only two variables, yet it explains almost 15% of the total variance of the data (see Fig. 59), whereas factor 1 explains almost 20% of the total variance, but also has 4 variables allocated to it. The "strength" of "brand" makes sense, as we earlier learned that almost 75% of the total variance of this question is explained by the 4 factors, making it one of the strongest variables in the model for the significance of the underlying factors.

#### 5. Analysis and interpretation of extracted factors

Lastly, we can allocate the different variables to the extracted factors with the rotated component matrix. The first iteration of the analysis yields the component matrix, where factor importance hasn't been relativized yet.

# ТШ

Komponentenmatrix <sup>a</sup>				
	Komponente			
	1	2	3	4
Digest	,695			
Freshness	,686		-,459	
Packaging	,668			
Color	,632			
Calories	,619	-,519		
Sparkling	,591			
Variety	,569			
Availability	,563	,444		
Taste	,511		-,471	
Benefits	,496	,469		
Healthiness	,488	-,589		
Brand	,501		,584	
Price	,404			,708

Extraktionsmethode: Hauptkomponentenanalyse.

a. 4 Komponenten extrahiert

Fig. 62: Component matrix for factor analysis

Rotating these components again with the orthogonal Varimax method, we then receive a sorted, final matrix. As explained above, we will only consider loadings higher than ±0.5. To clarify that "color" will be omitted, a cutoff value of 0.4 was specified here.

Rotierte Komponentenmatrix*				
	Komponente			
	1	2	3	4
Calories	,791			
Healthiness	,778			
Digest	,666			
Variety	,554		_	
Color	, <mark>491</mark>		, <mark>421</mark>	
Freshness		,793		
Sparkling		,765		
Taste		,685		
Brand			,848	
Packaging			,726	
Price				,709
Availability			, <mark>429</mark>	,676
Benefits				,599

 $\label{eq:extractions} Extraktions methode: Hauptkomponent enables and the second se$ 

Rotationsmethode: Varimax mit Kaiser-Normalisierung.

a. Die Rotation ist in 9 Iterationen konvergiert.

Fig. 63: Rotated component matrix for factor analysis



As a final result, we load "calories", "healthiness", "digestability" and "variety" on factor 1, "freshness", "sparkling" and "taste" on factor 2, "brand" and "packaging" on factor 3 and "price", "availability" and "benefits" on factor 4.

Looking at these groupings, we can now come up with names for our factors to see the underlying themes that determine most of the respondents' answers regarding what's important to them when choosing their number 1 energy drink.

Factor 1 could be labeled "Health effects", as most of the included variables relate to how well the human body can handle the drink. Fewer calories, healthier ingredients, better digestability and a larger variety in ingredients all have a positive impact on how good an energy drink will be for bodily health (or less harmful).

Factor 2 could be called "Drinking experience", since freshness, sparkling and taste combined create the experience when taking a sip from the drink and swallowing it. If an energy drink is fresh, sparkles and tastes good, people enjoy the process of drinking it more.

Factor 3 could be called "Marketing" as the entire idea of a brand represents certain attributes and attitudes people expect and associate with a certain product from a certain company. The packaging adds to that. If the can is beautifully designed and easy to use, people are more likely to take it off the shelf and buy it over others.

Factor 4 includes price, availability and benefits, which is why we could call it "priceperformance ratio", which describes how much of the benefits people desire get, given the money and effort they've exerted in attaining the drink. The more money people spend and the harder it is to get their preferred energy drink, the more important it becomes they receive the benefits they want from the drink.

Regarding how the factors are grouped together, all of the factors make psychological sense. "Health effects" are an issue most consumers are concerned with for many food and drink products. People also do not buy products they think they will not enjoy, hence "Drinking experience" is also a logic factor to include. "Marketing" has been proven to affect consumer behavior and decisions for a very long time. "Price-performance ratio" is also a well-known concept in consumer behavior research.

Our factor analysis has thus been successful in reducing the number of variables to 4 factors, which, combined, explain over 60% of the variance of all variables of question 18. This means these 4 factors are the main influence factors on what people think is important when choosing their favorite energy drink.



#### 9. Conclusion

Using various statistical analysis methods, we have learned a lot more about the consumption of energy drinks from the people in our data set.

We learned that most of the people in our data set consume energy drinks rarely and consider 1€ to 1.50€ as acceptable prices using frequency analyses. We found out that descriptive statistics do not always lead to meaningful conclusions and that sometimes, data must be formatted and corrected again mid-way through the analysis.

We saw from crosstabs that even though our sample indicated men tend to drink energy drinks more than women, we could not confirm this hypothesis on a significant level. Using inferential statistics, we created hypotheses about the population, such as men and women being equally satisfied with energy drinks, yet people in general always preferring their number 1 energy drink over number 2. Using a factor analysis, we were even able to aggregate several variables into 4 factors, which represent meaningful psychological constructs, by which importance of energy drink attributes can be measured.

However, each statistical study has its limits. For example, since we used convenience sampling, there might be a selection bias in our data - people who like energy drinks already are of course more likely to participate in a survey about energy drinks. Also, since the data was aggregated across so many data collectors (all students in the class), the same respondents might have taken the questionnaire multiple times (for example if two people from the class happened to ask the same person to participate and they did not decline the second request).

To verify and build on the claims made in this analysis, many more studies and surveys about energy drinks will be needed, with different sample sizes, selection methods, survey questions and analysis methods.

It seems that for statistics, the same remarks Stephen Hawking made about physical theories hold true, which explain both the beauty and the curse of scientific research:

"Any physical theory is always provisional, in the sense that it is only a hypothesis: you can never prove it. No matter how many times the results of experiments agree with some theory, you can never be sure that the next time the result will not contradict the theory."

-Stephen Hawking