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Emotions and exposure to risk: the influence of positive and negative emotions on portfolio decisions

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Emotions and exposure to risk: the influence of positive and negative emotions on portfolio decisions

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Abstract

This experimental study addresses the question of whether positive and negative emotions have an influence on diversification behaviour, and it reveals that only a small part of subjects take rational decisions and always choose the optimal portfolio. In addition, the study shows that the mood of subjects has an influence on their portfolio decisions and thus also on their exposure to risk. The average risk of the portfolio - measured against the standard deviation of the returns - is lower in the treatment entitled 'neutral' than in the treatments entitled 'positive' and 'negative'.

Keywords

positive affect; negative affect; mood; emotions; risk exposure; laboratory experiment; portfolio choice; investment decisions; correlation neglect; information processing; investor rationality

JEL classification

C91, D81, G11, G41

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1 Introduction

The danger of having a portfolio of securities which is not optimally diversified was shown in September 2015, for example: due to the Volkswagen Group's Dieselgate scandal, German car shares suffered considerable losses within a period of only a few days. Those who had a high proportion of automobile industry shares in their portfolio rapidly lost up to a third of the value of the portfolio. Markowitz (1952) showed that for risk-averse subjects it makes sense to hold diversified securities portfolios. Nevertheless, in reality many subjects hold insufficiently diversified securities portfolios (see, for example Ackert et al., 2015; Anderson, 2013; Hibbert et al., 2012; Ackert et al., 2011; Goetzmann and Kumar, 2008; Meulbroek, 2005; Polkovnichenko, 2005; Huberman and Sengmueller, 2004; Agnew et al., 2003; Poterba 2003; Mitchell and Utkus 2002; Guiso et al., 2002; Benartzi, 2001; Benartzi and Thaler, 2001; Barber und Odean, 2000; De Bondt, 1998; Kelly, 1995; Bode et al., 1994; French and Poterba, 1991; Blume and Friend, 1975; Lease et al., 1974).

There are many possible reasons for securities portfolios not being optimally diversified. Experimental economic research has already presented findings on this subject: the correlations between investment alternatives are frequently neglected by investors. Considerable empirical evidence already exists for this phenomenon of correlation neglect (see, for example Gubaydullina and Spiwoks, 2015; Eyster and Weizsäcker, 2010; Hedesström et al., 2006; Benartzi and Thaler, 2001). Many investors distribute their assets evenly across all of the investment alternatives available. This phenomenon, which is known as the 1/N heuristic, is a special form of correlation neglect. In the meantime, there are also significant empirical findings on this issue (see, for example, Fernandes 2013; Morrin et al., 2012; Baltussen and Post, 2011; Hedesström et al., 2006, and Benartzi and Thaler, 2001). Many investors allow themselves to be misled by irrelevant information, or attach too much importance to certain information (cf. Gubaydullina and Spiwoks, 2015; Kallir and Sonsino, 2009; Goetzmann and Kumar, 2008). Investment decisions are frequently skewed by an inappropriately strong focus on domestic financial instruments. This phenomenon is known as home bias, and has also been proven empirically (cf. Weber et al., 2005; Poterba, 2003; Mitchell and Utkus, 2002). Many investors also tend to see patterns where in reality there are none. This often leads to random processes being dealt with inappropriately. In this way, the so-called gambler's error can impede optimal decisions on diversification (see, for example Filiz et al., 2018; Stöckl et al., 2015; Huber et al., 2010).

The influence of emotions on decision-making is now well-established in the literature (for an overview see, for example George and Dane, 2016; Lerner et al., 2015; Vohs et al., 2007; Baker and Wurgler, 2007; Baumeister et al., 2007; Pham, 2007; Shiv et al., 2005; Nofsinger, 2005; Lucey and Dowling, 2005; Daniel et al., 2002; Hirshleifer, 2001; Loewenstein et al., 2001; Isen, 2000; Loewenstein, 2000; Schwarz, 2000; Elster, 1998; Bless et al., 1996; Elster, 1996; Johnson and Tversky, 1983).

In recent decades, the effects of sunshine, rain, cloud cover, wind strength, storms and other meteorological factors on market returns at share exchanges worldwide have been thoroughly investigated (Kim, 2017; Kaustia and Rantapuska, 2016; Apergis et al., 2016; Bassi et al., 2013; Lu and Chou, 2012; Mirza et al., 2012; Floros, 2011; Symeonidis et al., 2010; Kang et al., 2010; Shu and Hung, 2009; Chang et al., 2008; Keef and Roush, 2007; Chang et al., 2006; Dowling and Lucey, 2005; Cao and Wei, 2005; Tufan and Hamarat, 2004; Krivelyova and Robotti, 2003; Hirshleifer and Shumway, 2003; Kamstra et al., 2003; Pardo and Enric, 2002; Krämer und Runde, 1997; Saunders, 1993). While doing so, attempts were also made to create a connection between the weather and the mood of capital market protagonists. Hirshleifer and Shumway (2003) showed that share market returns on days when the sun shone in the morning were higher on average than on days with bad weather. This result was explained by sunshine favouring a positive atmosphere among investors. Kamstra et al. (2003) established that share market returns varied according to the length of the day, which has been interpreted in a similar way to the results Hirshleifer and Shumway (2003). Kaustia and Rantapuska (2016) carried out a similar study - however, they only observed a weak connection between the effect of the length of a respective day and investment decisions.

Experimental economic research is increasingly interested in the question of which influence positive and negative emotions have on investment decisions. Grable and Roszkowski (2008), for example, showed in an experimental study that subjects whose positive emotions predominate were willing to take greater financial risks. Kuhnen and Knutson (2011) carried out experiments to establish how different moods affected investment decisions. This revealed that subjects with predominantly negative emotions tend to choose low-risk investments. Subjects with predominantly positive emotions, on the other hand, tended to favour riskier investments. Subjects whose emotions are positive are more optimistic in relation to their investment decisions. Kaplanski et al. (2014) showed that the mood of investors had an influence on their expectations in terms of returns, and on their perception of risk. The happier the subjects were, the greater were their expectations of their returns, and the lower the presumed risk of stock market investments. Experiments carried out by Lee and Andrade (2014) showed that negative affects promote risk aversion in investment decisions. Lahav and Meer (2012) as well as Andrade et al. (2016) used experiments to examine the effect of emotions on speculative bubbles, whereby they established that speculative bubbles were larger in the case of positive affects than with negative affects. Breaban and Noussair (2018) followed a similar approach, though their findings were not as clear-cut as those of Lahav and Meer (2012) or of Andrade et al. (2016).

As one can see, there are a range of findings showing that the mood of investors can influence their investment decisions. However, as yet there have been no studies on whether the mood of investors also has an effect on their diversification behaviour and thus on the exposure to risk in differently composed portfolios. This research topic has, however, now been addressed by this study.

Chapter 2 deals with the design of the experiment. In Chapter 3, hypotheses are elaborated, and in Chapter 4 the results are presented and analysed. In Chapter 5 the most important results of the investigation are summarised.

2 Experimental design

2.1 Diversification decisions

Markowitz (1952) proceeds from a very simple starting point: a choice between two risky securities. The first security (x_1) has a comparatively low expected return (e_1) and a comparatively low risk exposure (s_1). The second security (x_2) has a higher expected return (e_2) and a higher risk exposure (s_2). As long as the two securities x_1 and x_2 are not fully positively correlated in terms of the level of their returns, the returns of the portfolios develop in a proportional way while their risk exposure is disproportionately low. When viewing expected returns and risk exposure simultaneously, the so-called efficient frontier emerges. The efficient frontier shows all the possible combinations of expected returns and risk which can be considered efficient. However, for a specific investor, only one point on this efficient frontier represents the optimal combination of securities. Which point that is depends on the shape of the field of indifference curves of the investor in question. However, it has not been possible until now to determine the exact characteristic of the indifference curve field of a specific subject. In order to nevertheless be able to differentiate between diversification decisions which are suboptimal and optimal, the approach used by Gubaydullina and Spiwoks (2015) is useful: in this method there are two securities x_1 and x_2 which both offer the same return (e1 = e2). In this way, the efficient frontier is reduced to a single point (cf. Gubaydullina and Spiwoks 2015, Figure 2). In a decision-making situation of this kind, the exact characteristic of the indifference curve field of an investor is no longer significant. It suffices to know whether the investor should be categorised as risk averse in order to be able to differentiate between optimal and suboptimal diversification. There are various well-established procedures for discovering whether a subject is risk loving, risk neutral or risk averse. In this study, the approach used by Holt and Laury (2002) is followed.

2.2 Tasks

Each subject has to make four investment decisions (Tasks 1-4), from whose success he or she is directly affected.

In <u>Task 1</u> there are two different securities to choose from (share A and share B). The subjects have to compile a portfolio which contains four shares. The possible portfolios are thus AAAA, AAAB, AABB, ABBB and BBBB. The subjects profit from the dividend payments. The price trends of the two shares are ignored in order to create a decision-making situation which is as clear as possible. The expectation value of the returns is thus solely based on the dividend payments. The dividend payments (= expectation value of the returns) of the two shares A and B are identical ($e_A = e_B$ = €1.50). However, they exhibit different risk profiles. Whereas share A generates €3 or €0, share B yields either €1 or €2 ($s_A > s_B$). Both events have a probability of occurrence of 50%. Whether a favourable or an unfavourable event occurs depends - in both companies - on the economic situation. The yield of the two shares are accordingly not independent of each other, they are entirely positively correlated (correlation coefficient = +1). The subjects are informed of these circumstances. Test questions are used to ensure that the subjects have understood this point of departure.

In Task 1, the subjects are informed about the movements in returns in the past ten years. The intention is that in this way they will obtain a specific impression of the possible events - of the completely positive correlation and of the different risk profiles of the two securities A and B.

Table 1: Dividend payments of the past ten years for share A and share B

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Share A	€3	€0	€3	€0	€0	€0	€3	€3	€0	€3	€?
Share B	€2	€1	€2	€1	€1	€1	€2	€2	€1	€2	€?

By mixing the two securities A and B, no reduction in risk can be achieved in view of the entirely positive correlation of the dividend payments. The ideal portfolio for risk-averse investors is thus BBBB (Table 2).

Table 2: Expectation value for the dividend payments and variance of the possible portfolios for Task 1

Portfolio composition	AAAA	AAAB	AABB	ABBB	BBBB
Expectation value of dividend payment	€6	€6	€6	€6	€6
Variance	36.0	25.0	16.0	9.0	4.0

At the end of the experiment, and in the presence of the subjects, the actual dividends of the shares A and B for the year 2016 are determined randomly by tossing a coin. The subjects then receive a payoff in the amount of the dividend payment of their portfolio. If there is a favourable random event (dividend of share A = €3 and dividend of share B = €2), the person who has chosen the portfolio AABB receives a payment of €10 (2 x €3 + 2 x €2). And the person who has chosen the portfolio AAAA receives a payment of €12 (4 x €3). If an unfavourable random event occurs (dividend of share A = €0 and dividend of share B = €1), the person who has selected the portfolio AABB receives €2 (2 x €0 + 2 x €1). The person who has chosen the portfolio AAAA receives €0 (4 x €0).

In Task 2, on the other hand, a choice can be made between two different investment alternatives (share X and share Q). The subjects are asked to compile a portfolio consisting of four shares. The possible portfolios are thus XXXX, XXXQ, XXQQ, XQQQ and QQQQ. The subjects profit from the dividend payments. The price trends of the two shares are ignored in order to create a decision-making situation which is as clear as possible. The expectation value of the returns is thus solely based on the dividend payments. The dividend payments (= expectation value of the returns) of the two shares X and Q are identical ($e_X = e_Q$ = €1.00).

The risk exposure of the two shares X and Q is also identical ($s_X = s_Q$). The two shares pay a dividend of either €0 or €2. With both shares the probability of the occurrence of these two events is 50%. The dividend payments of the shares X and Q are based on independent random processes (correlation coefficient = 0). The subjects are informed about these circumstances. Test questions are used to ensure that the subjects have understood this point of departure.

In Task 2, the subjects are informed about the course of the returns in the past ten years (Table 2). The intention is that in this way they will obtain a specific impression of the possible events. In addition, the intention is to make them realise that the dividend payments of the shares are entirely uncorrelated.

Table 3: Dividend payments of the past ten years for share X and share Q

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Share X	€0	€0	€2	€0	€0	€0	€2	€2	€2	€2	€?
Share Q	€0	€2	€2	€2	€0	€2	€0	€0	€2	€0	€?

By mixing the two shares X and Q, a significant reduction of risk exposure can be achieved in view of the uncorrelated movements in the dividend payments. The ideal portfolio for risk-averse investors is thus XXQQ (Table 4).

Table 4: Expectation value for the dividend payments and variance of the possible portfolios for Task 2

Portfolio management	QQQQ	QQQX	QQXX	QXXX	XXXX
Expectation value of dividend payment	€4	€4	€4	€4	€4
Variance	16.0	8.8	6.4	8.8	16.0

At the end of the experiment, and in the presence of the subjects, the actual dividends of the shares X and Q for the year 2016 are determined randomly (by tossing a coin). At the end of the game, the subjects then receive a payoff in the amount of the dividend payment of their portfolio. If there is an unfavourable random event for share X (dividend of share X = €2) and an unfavourable random event for share Q (dividend of share Q = €0), the person who has chosen portfolio XXQQ receives a payment of €4 (2 x €2 + 2 x €0). The person who has chosen the portfolio XXXQ receives a payment of €6 (3 X €2 + 1 X €0).

Task 3 is similar to Task 1. There is a choice between two different securities (share G and share H). The subjects have to compile a portfolio which contains four shares. The possible portfolios are thus GGGG, GGGH, GGHH, GHHH and HHHH. The subjects profit from the dividend payments. The price trends of the two shares are ignored in order to create a decision-making situation which is as clear as possible. The expectation value of the returns is thus solely based on the dividend payments. The dividend payments (= expectation value of the returns) of the two shares G and H are identical ($e_G = e_H$ = €1.50). However, they exhibit different risk profiles. Whereas share G generates either €3 or €0, share H yields either €1 or €2 (sG > sH). Both events have a probability of occurrence of 50%. Whether a favourable or an unfavourable event occurs depends - in both companies - on the economic situation. The yield of the two shares are accordingly not independent of each other; they are entirely positively correlated (correlation coefficient = +1). The subjects are informed about these circumstances. Test questions are used to ensure that the subjects have understood this point of departure.

No reduction in risk can be achieved by mixing the two securities G and H given the entirely positive correlation of the dividend payments. The ideal portfolio for risk-averse investors is thus HHHH (Table 5).

Table 5: Expectation value for the dividend payments and variance of the possible portfolios for Task 3

Portfolio composition Task 3	GGGG	GGGH	GGHH	GHHH	HHHH
Expectation value of the dividend payment	€6	€6	€6	€6	€6
Variance	36	25	16	9	4

Task 4 is similar to Task 2. There is a once again a choice between two different investment alternatives (share E and share F). The subjects are asked to compile a portfolio consisting of four shares. The possible portfolios are thus EEEE, EEEF, EEFF, EFFF and FFFF. The subjects profit from the dividend payments. The price trends of the two shares are ignored in order to create a decision-making situation which is as clear as possible. The expectation value of the returns is thus solely based on the dividend payments. The dividend payments (= expectation value of the returns) of the two shares E and F are identical ($e_E = e_F$ = €1.00). The risk exposure of the two shares E and F is also identical ($s_E = s_F$). The two shares have a dividend of either €0 or €2. With both shares the probability of the occurrence of these two events is 50%. The dividend payments of the shares E and F are based on independent random processes (correlation coefficient = 0).

By mixing the two shares E and F, a significant reduction of risk exposure can be achieved given the uncorrelated movement of the dividend payments. The ideal portfolio for risk-averse investors is thus EEFF (Table 6).

Table 6: Expectation value for the dividend payments and variance of the possible portfolios for Task 4

Portfolio composition	EEEE	EEEF	EEFF	EFFF	FFFF
Expectation value of the dividend payment	€4	€4	€4	€4	€4
Variance	16	8.8	6.4	8.8	16

2.3 Treatments

As this study investigates whether mood has effects on the diversification decisions of subjects and thus on the risk exposure of their portfolios, the mood of the subjects is influenced with brief film excerpts. Emotional film excerpts are a common and effective method to create emotions.[2] Film excerpts are also being increasingly used to influence moods in economic experiments (see, for example Andrade et al., 2016; Oswald et al., 2015; Ifcher and Zarghamee, 2014; Lahav and Meer, 2012; Ifcher and Zarghamee, 2011; Schaefer et al., 2010; Rottenberg et al., 2007; Kirchsteiger et al., 2006; Gross und Levenson, 1995;).

The selection of short film excerpts deployed here are taken from the study by Schaefer et al. (2010), in which more than 70 film excerpts were assessed with regard to their ability to create emotions. The film clips are clearly assigned to the moods which are desired. There are film excerpts which evoke negative emotions, and there are film excerpts which evoke positive emotions. And there are film excerpts which do not influence the mood of the viewers. These film sequences are described as neutral.

In order to create positive emotions, the following film excerpts were used in our experiment: (1) Benny and Joon (122 seconds): Benny (Johnny Depp) plays the fool in a café. (2) Life is Beautiful (266 seconds): a mother and son are re-united after the Second World War. (3) Dead Poets Society (163 seconds): all of the students in a class stand on their desks to show their solidarity with Mr. Keating (Robin Williams), who has just been fired. (4) Forrest Gump (121 seconds): father and son are reunited. (5) Dinner for Schmucks (101 seconds): complex humorous scenes.

In order to create negative emotions, the following film excerpts were used in our experiment: (1) Schindler's List (101 seconds): the SS storm a house and shoot everyone in it. (2) The Piano (42 seconds): a person's finger is chopped off deliberately with an axe. (3) The Blair Witch Project (232 seconds): final scene in which the protagonists are seemingly killed. (1) Schindler's List (76 seconds): bodies are burned in a concentration camp. (5) Saving Private Ryan (327 seconds): a war scene at Omaha Beach in the Second World War.

The film excerpts used here which do not affect the emotions of the subjects (neutral) are as follows: (1) The Lover (43 seconds): Marguerite (Jane March) gets into a car. She drives to a house in a busy street and knocks on a door. A Chinese man opens and she goes in. (2) Blue (40 seconds): a man is clearing up the drawers of his desk. A woman is walking along a street and says hello to another woman. (3) Train ride (58 seconds): a train travels through a green landscape.[3] (2) Blue (25 seconds): a woman goes up an escalator carrying a crate. (5) Blue (16 seconds): a person holds a piece of aluminium foil out of the window of a moving car.

In the experiment, three treatments are compared. In the negative treatment, the subjects watch a film excerpt which evokes negative emotions before making their portfolio decisions. In the positive treatment, the subjects watch a film excerpt which evokes positive

[2] There are various ways of influencing mood. This also includes real situations, memories and imagination, noises and music, presents, film clips and the so-called Velten technique (cf. Westermann et al., 1996).
[3] The film clip train ride is from the study by Gendolla and Krüsken, 2002.

emotions before making their portfolio decisions. In the neutral treatment, the subjects watch a film excerpt which does not have any effect on them before making their portfolio decisions.

In all three treatments it is only the film excerpts which differ. The rest of the experiment is the same in all three treatments, so in all three treatments the subjects have to carry out Tasks 1-4.

2.4 Sequence of the tasks and procedure of the experiment

After the subjects have read the thorough instructions, their mood is measured before the experiment with the following question:

> How are you feeling now? Please mark the adequate number!
>
> 1—2—3—4—5—6—7—8—9—10
>
> very bad   very good

Then the test questions about the decision-making situations (Tasks 1-4) are posed. Only those who answer the test questions correctly are allowed to participate in the experiment. This ensures that the subjects understand which decision can lead to which consequences for their payoff.

Subsequently - before the first diversification task - their mood is influenced with a corresponding film clip. Depending on the treatment, a film clip is shown which evokes positive emotions (positive treatment), negative emotions (negative treatment), or no emotions (neutral treatment). After the film excerpt a manipulation check takes place to test whether the intended mood has been created among the subjects.

For the manipulation check the following question is posed:[4]

> Which emotions did you experience while watching the movie clip?
>
> Please mark one number accordingly!
>
> 1—2—3—4—5—6—7—8—9—10
>
> very negative   very positive

[4] Similar manipulation checks were also carried out in the studies by Andrade et al., 2016; Lahav und Meer, 2012; Rottenberg et al., 2007; Kirchsteiger et al., 2006.

Subsequently the subjects have to make their first diversification decision in Task 1. After this decision has been made, the subjects are shown the second film clip. Once again, depending on the treatment, a film clip is shown which evokes positive emotions (positive treatment), negative emotions (negative treatment), or no emotions (neutral treatment). After the film excerpt a manipulation check again takes place to test whether the intended mood has really been created among the subjects. Subsequently the subjects have to make their second diversification decision in Task 2. The same procedure is repeated until all four diversification decisions have been made.

Then the experiment examines - using the approach of Holt and Laury (2002) - whether the subjects should be categorised as risk averse, risk neutral or risk loving. This is absolutely necessary, because the portfolios with the lowest possible risk exposure (in Task 1: BBBB; in Task 2: XXQQ; in Task 3: HHHH, and in Task 4: EEFF) are only optimal for risk-averse investors. Risk-loving subjects, on the other hand, would normally always choose the portfolio with the highest variance. Risk-neutral subject are indifferent with regard to all of the portfolios, as their expectation value is always the same for all five possible portfolio alternatives.

Before the subjects make the ten decisions on their preference for lottery A or lottery B, depending on the treatment a film excerpt is shown which evokes positive emotions (positive treatment), negative emotions (negative treatment), or no emotions at all (neutral treatment). After the film excerpt a manipulation check again takes place to test whether the intended mood has really been created among the subjects. Then the subjects make their ten decisions regarding lottery A or B.

After the subjects have made their decisions, the drawing of the random events for the securities of Tasks 1-4 and the draw for the lottery according to Holt and Laury (2002) are made. Following this the payoff is made - dependent on their choice of portfolio in the Tasks 1-4, and depending on their success in the lottery according to Holt and Laury (2002). In the diversification decision tasks up to €40 can be earned, and in the lottery up to €3.85. In addition, every participant receives a show-up fee of €1.50, so overall the subjects can earn up to €45.35. On average, the participants earn €24.44. The maximum was €38.35 and the minimum was €11.60. The survey takes an average of 40 minutes, so the payment can be described as attractive. Without exception, the subjects gave the impression of being concentrated and committed.

The experiment was carried out at the Ostfalia University of Applied Sciences in Germany with students from the Faculties of Automotive Engineering, Public Health Services and Business in the period from 12 August 2015 to 24 September 2015 in the Ostfalia Laboratory for Experimental Economic Research (OLEW). Overall, 123 students took part in the experiment in 37 sessions. From the Faculty of Business, 60 students took part in the experiment (48.78%), while from the Faculty of Automotive Engineering 40 students (32.52%), and from the Faculty of Public Health Services 23 students (18.70%) participated. Of these, 45 were women (36.59%) and 78 were men (63.41%). The number of participants per treatment was as follows: 44 participants in the negative treatment, 39 in the neutral treatment and 40 participants in the positive treatment. The participants were 24.3 years old on average.

In order to test the hypotheses, the subjects who proved to be risk neutral or risk loving in the procedure used by Holt and Laury (2002) were eliminated from the experiment. In addition, those subjects who chose variant A in the tenth decision in the test according to Holt and Laury (2002) were also eliminated, because it must be assumed that subjects who do not choose variant B in the tenth decision of the lottery have not really understood the decision-making situation. This is because in the tenth decision variant B is clearly superior to variant A - regardless of the risk preferences of the subject. The number of participants after the necessary thinning out was as follows: 26 participants in the negative treatment, 24 in the neutral treatment and 25 participants in the positive treatment.

The experiment was programmed with z-Tree (cf. Fischbacher, 2007). The instructions, test questions and screenshots from the experiment can be found in the appendices.

3 Hypotheses

As the expectation values of the five portfolio alternatives are the same, the optimal diversification for risk-averse subjects is to choose the portfolio with the minimum variance. However, there are many empirical findings which show that in practice a large number of portfolios are not optimally diversified (see the introduction). It cannot therefore be expected that risk-averse subjects will always choose the portfolio composition which minimises risk exposure. Hypothesis 1 is therefore: risk-averse subjects will not always choose the minimum variance portfolio in Tasks 1-4. Null hypothesis 1 is thus: all (risk-averse) subjects will only choose the minimum variance portfolio in Tasks 1-4.

There are numerous empirical findings showing that positive emotions can reduce the perception of risk in investment decisions (see, for example Conte et al., 2018; Kaplanski et al., 2014; Stanton et al., 2014; Kuhnen and Knutson, 2011; Shu, 2010; Grable and Roszkowski, 2008; Yuen and Lee, 2003; Forgas, 1998). It can thus be expected that the minimum variance portfolio will be selected less frequently in the positive treatment than in the neutral treatment. Hypothesis 2 is therefore: the average variance of the selected portfolios is higher in the positive treatment than in the neutral treatment. Null hypothesis 2 is thus: the average variance of the selected portfolios is not higher in the positive treatment than in the neutral treatment.

There are some empirical findings which show that negative emotions also have an inhibitive effect on subjects who based their own decisions on rational considerations (see, for example Conte et al., 2018; Gambetti and Giusbert, 2012; Lee and Andrade, 2011; Pham, 2007; Kliger and Levy, 2003; Tiedens and Linton, 2002; Lerner and Keltner, 2001; Leith and Baumeister, 1996). It can thus be expected that in the negative treatment the minimum variance portfolio is chosen less frequently than in the neutral treatment. Hypothesis 3 is therefore: the average variance of the selected portfolios in the negative treatment is higher than in the neutral treatment. Null hypothesis 3 is thus: the average variance of the selected portfolios in the negative treatment is not higher than in the neutral treatment.

If it is correct that positive and negative emotions contribute equally to a weakening of rational behaviour, it can then be presumed that there are no significant differences with regard to portfolio decisions in the positive and negative treatments. Hypothesis 4 is therefore: the average variance of the selected portfolios is the same in the positive and negative treatments. Null hypothesis 4 is thus: there is a significant difference in the average variance between the positive and negative treatments.

If it is correct that a neutral mood tends to contribute more towards making meaningful investment decisions than a positive or negative mood, this must also be reflected in the risk-adjusted payments, i.e. in the performance of the subjects. Hypothesis 5 is therefore: subjects who make their investment decisions in the neutral treatment will obtain higher risk-adjusted payments than subjects in the positive and negative treatments. Null hypothesis 5 is thus: subjects who take part in the neutral treatment will not obtain significantly higher risk-adjusted payments than subjects in the positive and negative treatments.

4 Results of the experiment

4.1 The effectiveness of influencing mood

First of all, we consider whether it has been possible to create the respective desired mood in the three treatments. The first measurement of mood takes place before the presentation of the first film excerpt (round 0). In Figure 1 it can clearly be seen that the mood in round 0 - i.e. before the targeted creation of a mood - was rather good in all three treatments. The median of round 0 in all three treatments was 8.

The average mood in the five rounds in which a film excerpt was presented to create a certain mood was as follows: in the negative treatment it was 3.09 (SD 1.42), in the neutral treatment it was 5.67 (SD 1.14) and in the positive treatment it was 7.32 (SD 1.36). In Figure 1 it can be clearly seen in the box plots that the creation of a specific mood in the individual treatments was successful.

Figure 2 also shows box plots on the mood of the subjects in the three treatments. It summarises the five rounds in which film excerpts were presented to manipulate moods.

It is clearly recognisable that the mood of the subjects varies considerably between the three treatments. The box for the negative treatment extends from 2.1 to 3.8. The box for the neutral treatment varies from 4.8 to 6.0. The box for the positive treatment varies from 6.2 to 8.2.

The fact that mood manipulation with the aid of the film clips worked is also shown by Table 7. The negative treatment shows significantly lower mood values than the positive treatment ($z= -7.466$, $p= 0.0000$; Mann-Whitney U test). The negative treatment shows significantly lower mood values than the neutral treatment ($z= -6.417$, $p= 0.0000$; Mann-Whitney U test). The positive treatment shows significantly higher average mood values than the neutral treatment ($z= 5.089$, $p= 0.0000$; Mann-Whitney U test).

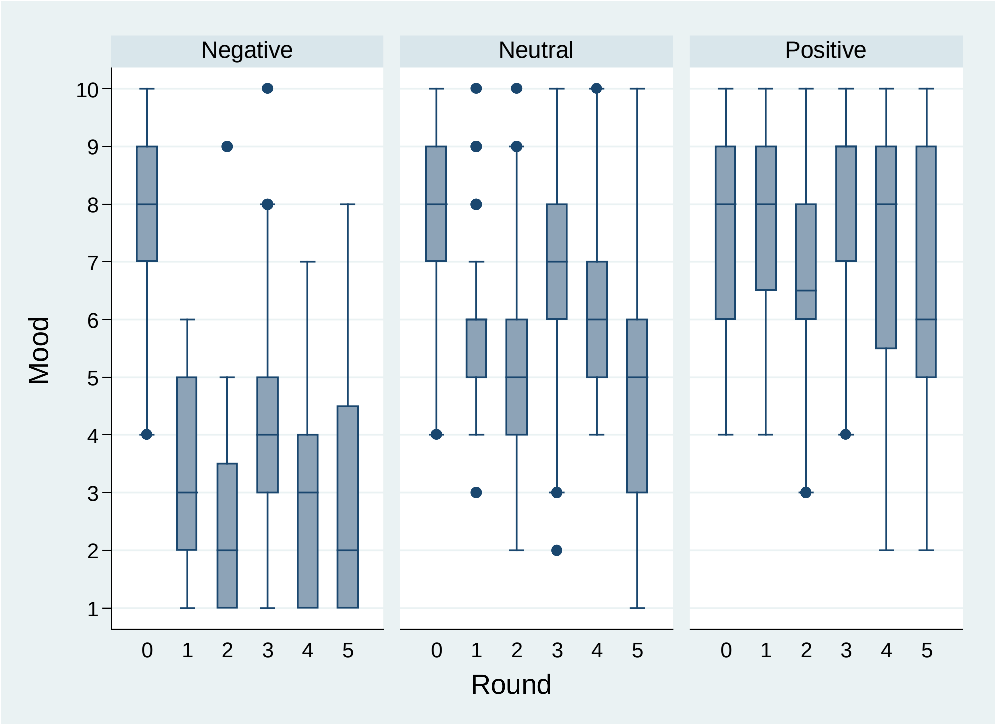

Figure 1: Box plots on the mood of the subjects in the respective rounds of the game according to treatments

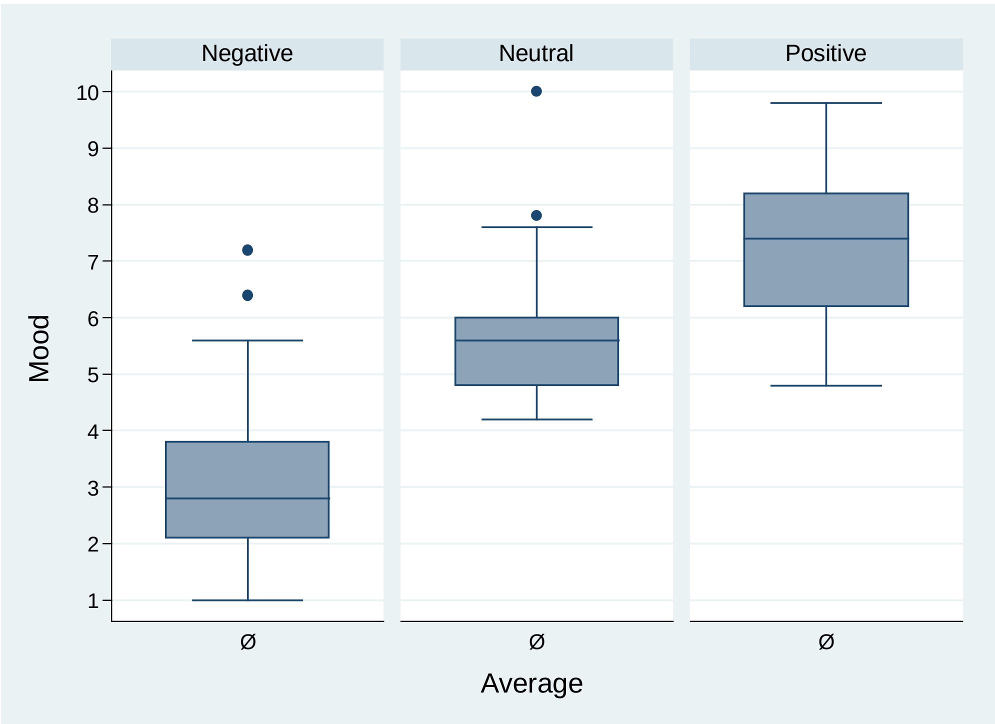

Figure 2: Box plots of mood after the treatments (summary of rounds 1-5)

Table 7: Average mood of the subjects in the respective rounds

Treatment	#	Average mood per round (standard deviation) Before the experiment	Round 1	Round 2	Round 3	Round 4	Round 5	Ø
Negative treatment	44	7.84 (1.57)	3.36 (1.62)	2.39 (1.78)	4.00 (1.97)	2.82 (1.59)	2.87 (2.06)	3.09*** (1.42)
Neutral treatment	39	7.92 (1.36)	5,79 (1.49)	5.05 (1.73)	6.62 (1.99)	6.00 (1.49)	4.87 (2.04)	5.67*** (1.14)
Positive treatment	40	7,43 (1.60)	7,55 (1.66)	6.85 (2.03)	8.18 (1.74)	7.33 (2.35)	6.68 (2.31)	7.32*** (1.36)

The significant values are highlighted (*** p<0.01; ** p<0.05, * p<0.1)
For the calculation of the average values (Ø), the figures of rounds 1-5 were used.

Overall it can be stated that the deployment of the film excerpts led to the desired results. In each of the three treatments, the desired mood was predominant. In the positive treatment positive emotions prevailed. In the neutral treatment, a generally average mood was present, and in the negative treatment, negative emotions predominated. To this extent, the approach was very well suited to answering the questions posed.

4.2 Rational strategy

Now we will take a look at the percentage distribution of the portfolios in the three treatments (Table 8). In the upper part of Table 8, Tasks 1 and 3 are listed. For risk-averse investors, the alternatives BBBB and HHHH respectively represent a rational strategy in the Tasks 1 and 3, because for all of the possible portfolio structures, the expectation value of the payment is identical. However, the risk exposure (variance) in the portfolios BBBB and HHHH is significantly lower than in the other portfolio alternatives. In all three treatments there are clear deviations from the rational strategy. In the negative treatment, only 13.46% of the participants chose the optimal portfolio. In the neutral treatment, this even falls to 8.33%. And in the positive treatment, only 12% of the participants chose the optimal portfolio.

In the upper part of the table, Tasks 2 and 4 are illustrated. The rational strategy here would be to choose a mix of two portfolios. The portfolios QQXX and EEFF have the same expectation value for the payment as the four other portfolio alternatives, but the risk exposure (variance) is considerably lower here than in the other four portfolio alternatives. The subjects were obviously able to deal significantly better with this starting position. In the negative treatment, 69.23% of the risk-averse participants chose the optimal portfolio. In the neutral treatment, this even rose to 75%. In the positive treatment, 70% of the risk-averse subjects chose the optimal portfolio.

Table 8: Percentage distribution of the portfolios in the three treatments

	Percentage distribution of the portfolios				
Portfolios Task 1	AAAA	AAAB	AABB	ABBB	BBBB
Portfolios Task 3	GGGG	GGGH	GGHH	GHHH	HHHH
Variance	36	25	16	9	4
Rational strategy	0.00%	0.00%	0.00%	0.00%	100.00%
Negative treatment	7.69%	19.24%	26.92%	32.69%	13.46%
Neutral treatment	0.00%	10.42%	31.25%	50.00%	8.33%
Positive treatment	4%	26%	26%	32%	12%
Portfolios Task 2	QQQQ	QQQX	QQXX	QXXX	XXXX
Portfolios Task 4	EEEE	EEEF	EEFF	EFFF	FFFF
Variance	16	8.8	6.4	8.8	16.0
Rational strategy	0%	0%	100%	0%	0%
Negative treatment	5.77%	13.46%	69.23%	5,77%	5.77%
Neutral treatment	6.25%	6.25%	75.00%	10,42%	2.08%
Positive treatment	10%	6.00%	70.00%	6,00%	8.00%

Null hypothesis 1 is: all risk-averse subjects will choose the minimum variance portfolios in Tasks 1-4. This null hypothesis clearly has to be rejected. Hypothesis 1 can thus be viewed as confirmed for the time being. The subjects do not always choose the optimal portfolio. In other words, they do not always take a rational approach. These results are in line with those of Ackert et al., 2015; Gubaydullina and Spiwoks, 2015; Ackert et al. 2011; Eyster and Weizsäcker, 2010; Goetzmann and Kumar, 2008, and Hedesström et al., 2006.

This is also reflected by an unnecessarily high risk exposure. In Table 9, the average variance for the minimum variance portfolio and the average variance of the portfolios chosen by the subjects are compared.

Table 9: Average variance of the rational strategy and the average variance of the portfolios chosen by the subjects in the three treatments

Treatment	Rational strategy Average variance	Actual: Average variance	T-test p-value
Negative treatment	5.2	11.67	0.0000***
Neutral treatment	5.2	10.02	0.0000***
Positive treatment	5.2	11.94	0.0000***

The significant values are highlighted (*** p<0.01; ** p<0.05, * p<0.1)

Here it is also revealed that the subjects frequently fail to choose the minimum variance portfolio, although all five portfolio alternatives exhibit the same expectation value for the payment. This way of evaluating the data also leads to the rejection of null hypothesis 1.

4.3 The influence of mood on portfolio decisions

In order to compare the average risk exposure (variance) of the three treatments, first of all the average risk exposure of each individual subject is established and entered into a histogram of the average risk exposure according to treatments (Figure 3).

It is noticeable that in the neutral treatment the distribution takes the form of a peak which is clearly skewed to the right. By contrast, distribution in the negative and positive treatments shows a broader spread and is only slightly skewed to the right. This means that the average risk exposure of the subjects in the neutral treatment was lower than the average risk exposure of subjects in the positive and negative treatments. This also becomes clear when viewing the distribution of the average variances below ten. In the neutral treatment, significantly more than half of the subjects are below this limit. In the positive and negative treatments, on the other hand, significantly less than half of the subjects are below this limit.

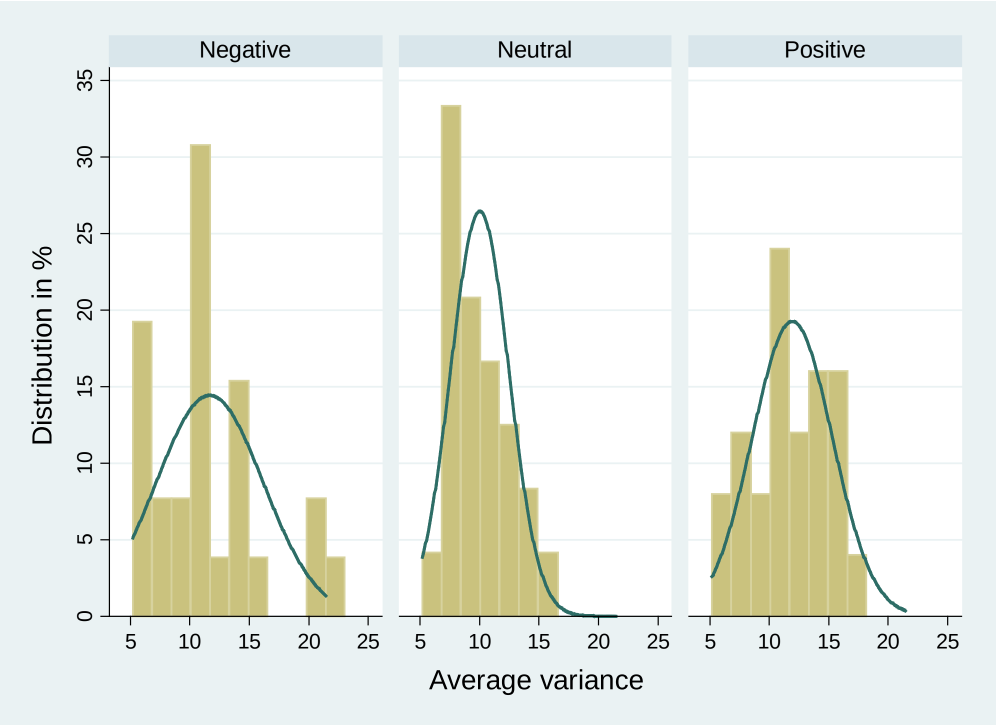

Figure 3: Percentage distribution of the average variance in the three treatments

The small but easily recognisable differences in average risk exposure in the three treatments are also shown when viewing the box plots (Figure 4). In the neutral treatment, the median - at 9.45 - is clearly below the medians of the positive (11.7) and negative (11.2) treatments. When viewing figures 3 and 4, differences between the neutral treatment on the one hand and the positive and negative treatments on the other are recognisable.

Whether these differences are significant was examined with the Wilcoxon rank sum test. First of all the positive treatment was compared to the negative treatment.

The average risk exposure (variance) was significantly higher in the positive treatment at 11.94 than in the neutral treatment at 10.02. In the Wilcoxon rank sum test, the difference - with a p-value of 0.0294 - proved significant (Table 10). Null hypothesis 2 thus has to be rejected. Hypothesis 2 states that the average variance of the selected portfolios in the positive treatment is higher than in the neutral treatment. This hypothesis can be viewed as confirmed for the meantime.

Table 10: Risk exposure (average variance of the portfolios) in the positive and neutral treatments

Average variance Positive treatment	Average variance Neutral treatment	Wilcoxon rank sum test p-value
11.94	10.02	0.0294**

The significant values are highlighted (*** p<0.01; ** p<0.05, * p<0.1)

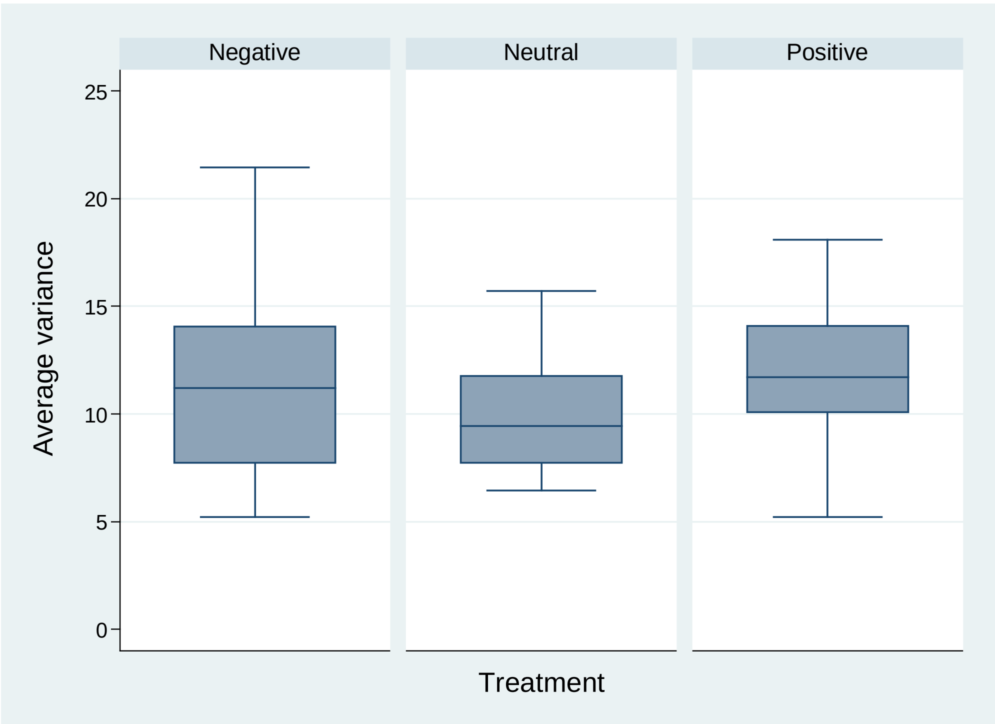

Figure 4: Average variance in the three treatments

The findings of Grable and Roszkoswki (2008) as well as those of Kuhnen and Knutson (2011), who discovered that there is a greater willingness to take risks when positive emotions are present, are thus confirmed.

Next, we examined whether the risk exposure in the negative treatment is also recognisably higher in the negative treatment than in the neutral treatment. The average variance in the negative treatment (11.67) was significantly higher than in the neutral treatment (10.02), but in the Wilcoxon rank sum test this difference proved to be non-significant (Table 11). Null hypothesis 3 therefore cannot be rejected. Hypothesis 3 states that the average variance in the negative treatment is higher than in the neutral treatment. This expectation was not confirmed in a statistically significant way.

Table 11: Risk exposure (average variance of the portfolios) in the negative and neutral treatments

Average variance Negative treatment	Average variance Neutral treatment	Wilcoxon rank sum test p-value
11.67	10.02	0.2420

The significant values are highlighted (*** p<0.01; ** p<0.05, * p<0.1)

This leaves the question of whether the average risk exposure of the positive treatment and the negative treatment deviate significantly from each other. The average variance of the negative treatment was 11.67, and that of the positive treatment was 11.94 (Table 12). This relatively small difference revealed itself to be insignificant in the Wilcoxon rank sum test.

Table 12: Risk exposure (average variance of the portfolios) in the negative and positive treatments

Average variance Negative treatment	Average variance Positive treatment	Wilcoxon rank sum test P-value
11.67	11.94	0.3956

The significant values are highlighted (*** p<0.01; ** p<0.05, * p<0.1)

Null hypothesis 4 thus has to be rejected. Hypothesis 4 states that the average variance of the selected portfolios is not significantly different in the positive and negative treatments. This hypothesis can thus be viewed as confirmed for the meantime.

4.4 The influence of mood on risk-adjusted returns

Finally we examined whether the mood of the subjects was also reflected in their risk-adjusted payoffs (performance). To do so, we deployed a simplified performance benchmark. The risk-adjusted payoff (*RA*) is determined as follows.

(1)

$$RA = \frac{\text{Payoff}}{1 + (\frac{Variance}{100})}$$

In order to be able to compare the performance (risk-adjusted payoff) of the subjects in the three treatments, first of all the performance of each individual subject was determined and then entered into a histogram according to treatments (Figure 5). It is noticeable that in the neutral treatment the distribution takes the form of a slight peak which is skewed to the left. By contrast, distribution in the negative and positive treatments is slightly skewed to the right. In addition, in the neutral treatment the risk-adjusted payoffs of the subjects were over 20. In the positive and negative treatments on the other hand, over 40% and over 30% of the subjects respectively were below 20.

When viewing the box plots, the differences between the three treatments become clear (Figure 6). In the neutral treatment, the median - at 26.55 - is clearly above the medians of the positive (21.26) and negative (23.18) treatments. This means that the performance of the subjects in the neutral treatment was better than the performance of subjects in the positive and negative treatments. Whether these differences are significant was then examined with the Wilcoxon rank sum test. First of all the positive treatment was compared to the neutral treatment, and then the negative and the neutral were compared.

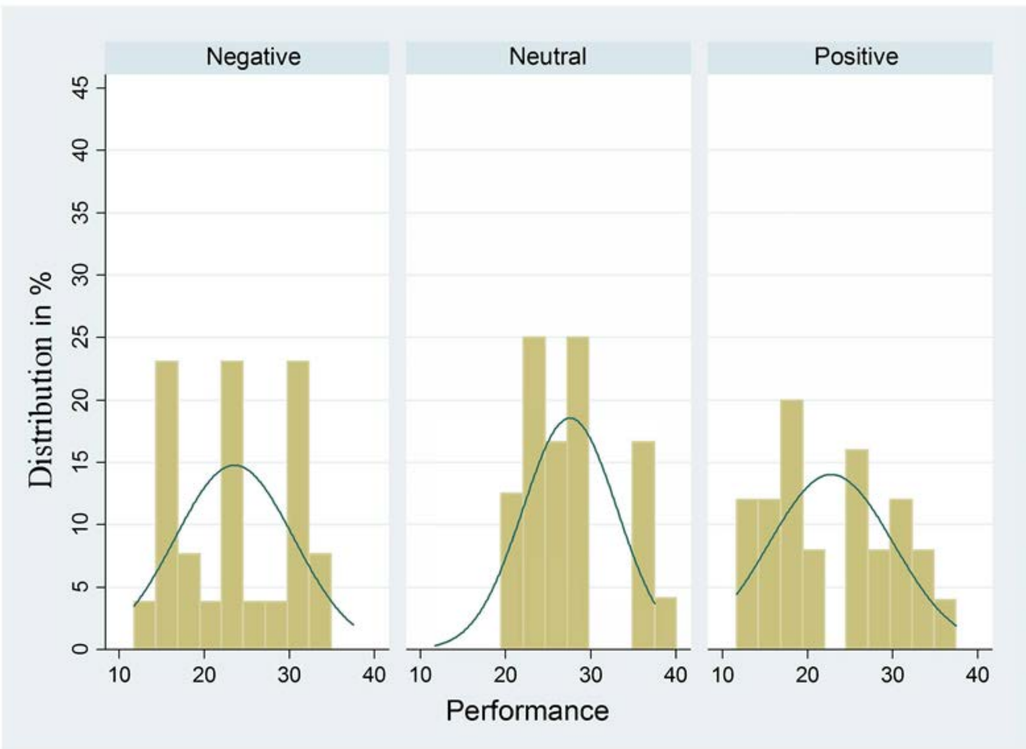

Figure 5: Percentage distribution of performance (risk-adjusted payoff) in the three treatments

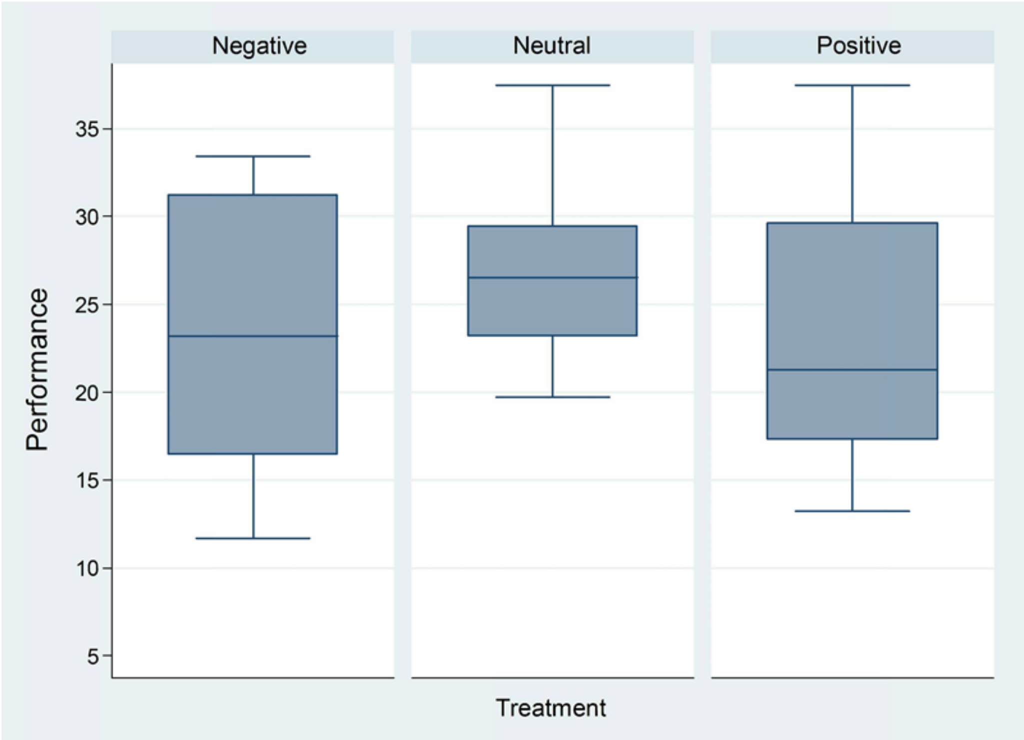

Figure 6: Risk-adjusted payoffs in the three treatments

The average performance was significantly higher at 27.52 in the neutral treatment than in the positive treatment at 22.81. In the Wilcoxon rank sum test, the difference - with a p-value of 0.0285 - proved to be significant (Table 13). The average performance was also significantly higher at 27.52 in the neutral treatment than in the positive treatment at 23.53. In the Wilcoxon rank sum test, the difference - with a p-value of 0.0545 - again proved to be significant (Table 14).

Table 13: Performance (risk-adjusted payoff) in the positive and neutral treatments

Average performance Positive treatment	Average performance Neutral treatment	Wilcoxon rank sum test p-value
22.81	27.52	0.0285**

The significant values are highlighted (*** p<0.01; ** p<0.05, * p<0.1)

Table 14: Performance (risk-adjusted payoff) in the negative and neutral treatments

Average performance Negative treatment	Average performance Neutral treatment	Wilcoxon rank sum test P-value
23.53	27.52	0.0545*

The significant values are highlighted (*** p<0.01; ** p<0.05, * p<0.1)

Thus, null hypothesis 5 clearly has to be rejected. Hypothesis 5 states that the subjects who make their investment decisions in the neutral treatment will obtain higher risk-adjusted payments than the subjects in the positive and negative treatments. This hypothesis can be viewed as confirmed for the meantime.

5 Summary and conclusion

For risk-averse subjects it is usually meaningful to diversify their portfolios (Markowitz, 1952). However, practice shows that many subjects have poorly diversified securities portfolios. Furthermore, some studies show that personal mood can have an influence on investment decisions. However, until now the question of whether positive and negative emotions have an influence on diversification behaviour and thus on risk exposure has not been investigated.

The design of the experiment is loosely based on the work of Gubaydullina and Spiwoks (2015). Each subject has to take four investment decisions. In each task the subjects can choose between two different securities. The subjects have to compile a portfolio which contains four shares, and they profit from the dividend payments. The dividend payments of the shares are based on a random process. The price movements of the two shares are ignored in order to create a decision-making situation which is as clear as possible. Mood is influenced by positive (in the positive treatment), negative (in the negative treatment) and neutral film excerpts (in the neutral treatment). Manipulation checks show whether the influencing of mood by the film clips has been successful.

The results of the experiment show that the mood of the subjects has an influence on their diversification behaviour. This becomes clear as soon as risk exposure is considered: the average risk exposure in the neutral treatment (10.02) is lower than in the positive treatment (11.94) and the negative treatment (11.67).

In addition, a neutral mood leads to the subjects obtaining higher risk-adjusted payoffs. The average risk-adjusted performance was significantly higher at 27.52 in the neutral treatment than in the positive treatment at 22.81 and in the negative treatment at 23.53.

Positive and negative moods lead to higher risk exposure and to lower risk-adjusted payoffs than a neutral mood. From this one can derive the recommendation that investment processes should as far as possible not be affected by emotions. It would seem wise to develop systematic investment rules and to strictly orientate the investment process towards them, or to only let groups of persons (such as an investment committee) take investment decisions rather than individuals.

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Appendix 1: Instructions for the experiment

The game

In the first section you will take diversification decisions for a portfolio in four different tasks. In each task you receive four free shares. Two companies are available to choose from (e.g. company K and company L). You can then choose whether you want to have 4 K shares, 4 L shares, 3 K shares and 1 L share, 3 L shares and 1 K share, or 2 K shares and 2 L shares. The dividend payments which your four shares yield in 2016 are paid out to you. Movements in the prices of the shares are of no significance to you. In the second section you make ten decisions for a lottery draw.

Before each task you are shown a short film excerpt lasting no longer than a minute. In each task you have five minutes time to enter your decisions. You will be given detailed information on the tasks in the respective sections.

Payment

You will receive a basic payment of €1.50. In addition, you can receive dividend payments up to €40 in the first section, and up to €3.85 in the lottery in the second section. In total you can thus earn up to €45.35. Payment is made at the end of the experiment.

Information

Please remain quiet during the experiment.

Please do not look at your neighbour's screen.

No aids are permitted (calculators, smartphones etc.). All electronic devices must be switched off.

Please note the respective time limits given on the upper right of the screen. If you do not enter anything during this time you will not receive any payment for the respective task.

Appendix 2: Test questions for the game

Multiple choice test questions:

Test question 1: What is your task in this game?

ʘ Solving mathematical problems.

ʘ Making diversification decisions and participating in a lottery. (correct)

ʘ Making economic forecasts.

Test question 2: How many companies are represented in each task and how many free shares do you receive?

ʘ Four companies are represented in each task, and there are 2 free shares to choose from.

ʘ Two companies are represented in each task, and there are 2 free shares to choose from.

ʘ Two companies are represented in each task, and there are 4 free shares to choose from. (correct)

Test question 3: What does the payment in the first section depend on?

ʘ On the movement of the share prices.

ʘ On the dividend payments. (correct)

ʘ On the level of the DAX.

Test question 4: How many possibilities are there for the diversification of your portfolio in each task?

ʘ 2

ʘ 4

ʘ 5 (correct)

Appendix 3: Test questions on the lottery

Multiple-choice test questions:

Test question 1: How high are the minimum and maximum payoffs in the lottery?

ʘ The minimum payment is €0.00 and the maximum payment is €1.60

ʘ The minimum payment is €0.10 and the maximum payment is €3.85. (correct)

ʘ The minimum payment is €0.10 and the maximum payment is €1.60.

Test question 2: If the roll of the dice selects the 7th decision, you have chosen variant A in the 7th decision, and you have drawn a white table tennis ball from the pot, how much is your payoff?

ʘ €0

ʘ €2

ʘ €1.60 (correct)

Test question 3: If the roll of the dice selects the 10th decision, how many white table tennis balls are in the pot?

ʘ 10

ʘ 0 (correct)

ʘ 5

Test question 4: If the roll of the dice selects the fourth decision, how many yellow table tennis balls are in the pot?

ʘ 6

ʘ 0

ʘ 4 (correct)

Appendix 4: Measuring risk preferences based on Holt and Laury (2002)

The lottery test used by Holt and Laury (2002) was modified slightly here. In the lottery there are 10 risk stages and two variants. Variant A (risk averse) with the possibility of payments of €1.60 or €2, and variant B (risk loving) with the payment possibilities €0.10 or €3.85. The lower payment is made when a white table tennis ball is drawn, and the higher payment if a yellow table tennis ball is drawn from the pot (and replaced). The risk levels indicate how many white and yellow balls are in the pot (Table 4). For every risk stage the subjects have to decide whether they want to choose variant A or B.[5] The risk level is determined with a ten-sided die. The higher the risk level, the higher the probability of receiving a larger payment. Two examples: at risk level 1, 9 white table tennis balls and one yellow table tennis ball are in the pot. At risk level 8, 9 two white table and eight yellow table tennis balls are in the pot.

Table A-1: Lottery

Risk level	Variant A:				Variant B:				Decision A or B
	p(€2) yellow		p(€1.60) white		p(€3.85) yellow		p(€0.10) white		
1	10%	€2	90%	€1.60	10%	€3.85	90%	€0.10	
2	20%	€2	80%	€1.60	20%	€3.85	80%	€0.10	
3	30%	€2	70%	€1.60	30%	€3.85	70%	€0.10	
4	40%	€2	60%	€1.60	40%	€3.85	60%	€0.10	
5	50%	€2	50%	€1.60	50%	€3.85	50%	€0.10	
6	60%	€2	40%	€1.60	60%	€3.85	40%	€0.10	
7	70%	€2	30%	€1.60	70%	€3.85	30%	€0.10	
8	80%	€2	20%	€1.60	80%	€3.85	20%	€0.10	
9	90%	€2	10%	€1.60	90%	€3.85	10%	€0.10	
10	100%	€2	0%	€1.60	100%	€3.85	0%	€0.10	

After the experiment the dividend payments are determined by tossing a coin. In order to determine the winnings of the lottery, first of all a ten-sided die is thrown to decide the risk level. Then the table tennis balls are placed in the pot in accordance with the risk level and every subject draws a table tennis ball from the pot. The ball is then returned to the pot.

[5] Before the selection of the lottery, the subjects have answered four test questions. The test questions check whether the subjects have understood the lottery.

Appendix 5: Screenshot of the experiment with z-Tree (reconstructed in order to improve readability)

How are you feeling now? Please mark the adequate number!

very bad ʘ ʘ ʘ ʘ ʘ ʘ ʘ ʘ ʘ ʘ very good

1–2–3–4–5–6–7–8–9–10

O.K.

Figure A-1: Measurement of mood before the experiment

Please answer the following test questions about the game:

Test question 1: What is your task in this game?

ʘ Solving mathematical problems.

ʘ Making diversification decisions and participating in a lottery.

ʘ Making economic forecasts.

Test question 2: How many companies are represented in each task and how many free shares do you receive?

ʘ 4 companies are represented in each task, and there are 2 free shares to choose from.

ʘ 2 companies are represented in each task, and there are 2 free shares to choose from.

ʘ 2 companies are represented in each task, and there are 4 free shares to choose from.

Test question 3: What does the payment in the first section depend on?

ʘ On the movement of the share prices.

ʘ On the dividend payments.

ʘ On the level of the DAX.

Test question 4: How many possibilities are there for the diversification of your portfolio in each task?

ʘ 2

ʘ 4

ʘ 5

O.K.

Figure A-2: Test questions

Which emotions did you experience while watching the movie clip?

Please mark one number accordingly!

very negative ʘ ʘ ʘ ʘ ʘ ʘ ʘ ʘ ʘ ʘ very positive

1–2–3–4–5–6–7–8–9–10

O.K.

Figure A-3: Manipulation check after the attempt to influence mood

You can choose between two shares (share A and share B) of a specific sector of industry. You can read in the table how high the dividend payments for both shares were during the past 10 years. If the economic situation in the sector is good, the dividend of share A is €3 and that of share B is €2. If the economic situation in the sector is poor, the dividend of share A is €0 and that of share B is €1. The economic trend in this sector can vary from year to year and has to be viewed as a random process: the probability of a good or poor economic situation are 50% respectively.

Year	**Share A**	**Share B**
2006	**€3**	**€2**
2007	**€0**	**€1**
2008	**€3**	**€2**
2009	**€0**	**€1**
2010	**€0**	**€1**
2011	**€3**	**€2**
2012	**€3**	**€2**
2013	**€3**	**€2**
2014	**€0**	**€1**
2015	**€3**	**€2**
2016	**€?**	**€?**

You receive four free shares. You can choose whether you want to have 4 A shares, 4 B shares, 3 A shares + 1 B share, 3 B shares + 1 A share or 2 A shares and two B shares. The dividend payments which your four shares yield in 2016 are paid out to you. The dividend payments for 2016 are determined by tossing a coin. If it is heads, this means a good economic situation, while tails means a poor economic situation or a weak year. Movements in the prices of the shares are of no significance to you.

Make your selection now. **I select:**

ʘ 4 A shares

ʘ 4 B shares

ʘ 3 A shares + 1 B share.

ʘ 3 B shares + 1 A share.

ʘ 2 A shares + 2 B shares.

Please give brief reasons for your selection. These reasons have no effect on the payment, so you can write down your thoughts openly and honestly.

O.K.

Figure A-4: Diversification decision

You make your decisions on the next page. Each decision is a choice between variant A and variant B. Each variant is a type of lottery with different payoff sums and probabilities of occurrence. You make ten decisions. Enter your respective decision in the right-hand column of the table. One of these decisions will be used to determine your payoff in the lottery. This is done as follows: after you have made all ten decisions, a ten-sided dice is thrown to determine which of the ten decisions will be used. Each of the decisions thus has the same 10% probability of being used. Then the lottery you have chosen (A or B) is played.

The probability of occurrence is simulated with the help of a pot with table tennis balls: in a pot with 10 table tennis balls, the number of yellow balls indicates the probability with which the higher payoff sum will occur. Example for decision no. 8: In a pot with 10 table tennis balls, 8 are yellow and 2 are white. The probability that a randomly drawn table tennis ball is yellow is thus 80%. If the table tennis ball drawn card is yellow, you receive €2 in variant A and €3.85 in variant B. If, however, the table tennis ball drawn is white, you receive €1.60 in variant A and €0.10 in variant B. You thus make ten decisions (either for lottery A or B). One of these is randomly chosen (with a die) and played (with a pot and ten table tennis balls) – the result determines your payoff in the lottery. Please answer the following test questions about the lottery before you make your decisions.

No.	Variant A:				Variant B:			
	p(€2) yellow		p(€1.60) white		p(€3.85) yellow		p(€0.10) white	
1	10%	€2	90%	€1.60	10%	€3.85	90%	€0,10
2	20%	€2	80%	€1.60	20%	€3.85	80%	€0.10
3	30%	€2	70%	€1.60	30%	€3.85	70%	€0.10
4	40%	€2	60%	€1.60	40%	€3.85	60%	€0.10
5	50%	€2	50%	€1.60	50%	€3.85	50%	€0.10
6	60%	€2	40%	€1.60	60%	€3.85	40%	€0.10
7	70%	€2	30%	€1.60	70%	€3.85	30%	€0.10
8	80%	€2	20%	€1.60	80%	€3.85	20%	€0.10
9	90%	€2	10%	€1.60	90%	€3.85	10%	€0.10
10	100%	€2	0%	€1.60	100%	€3.85	0%	€0.10

Test question 1: How high are the minimum and maximum payoffs in the lottery?

ʘ The minimum payoff is €0.00 and the maximum payoff is €1.60.

ʘ The minimum payoff is €0.10 and the maximum payoff is €3.85.

ʘ The minimum payoff is €0.10 and the maximum payoff is €1.60.

Test question 2: If the roll of the dice selects the 7th decision, you have chosen variant A in the 7th decision, and you have drawn a white table tennis ball from the pot, how high is your payoff?

Θ €0.00

Θ €2.00

Θ €1.60

Test question 3: If the roll of the dice selects the 10th decision, how many white table tennis balls are in the pot?

Θ 10

Θ 0

Θ 5

Test question 4: If the roll of the dice selects the 4th decision, how many yellow table tennis balls are in the pot?

Θ 6

Θ 0

Θ 4

O.K.

Figure A-5: Lottery

No.	Variante A:				Variante B:			
	p(€2) yellow		p(€1.60) white		p(€3.85) yellow		p(€0.10) white	
1	10%	€2	90%	€1.60	10%	€3.85	90%	€0.10
2	20%	€2	80%	€1.60	20%	€3.85	80%	€0.10
3	30%	€2	70%	€1.60	30%	€3.85	70%	€0.10
4	40%	€2	60%	€1.60	40%	€3.85	60%	€0.10
5	50%	€2	50%	€1.60	50%	€3.85	50%	€0.10
6	60%	€2	40%	€1.60	60%	€3.85	40%	€0.10
7	70%	€2	30%	€1.60	70%	€3.85	30%	€0.10
8	80%	€2	20%	€1.60	80%	€3.85	20%	€0.10
9	90%	€2	10%	€1.60	90%	€3.85	10%	€0.10
10	100%	€2	0%	€1.60	100%	€3.85	0%	€0.10

Now please make the ten decisions:

Which variant would you rather play – A or B?

No. 1: ʘ A ʘ B

No. 2: ʘ A ʘ B

No. 3: ʘ A ʘ B

No. 4: ʘ A ʘ B

No. 5: ʘ A ʘ B

No. 6: ʘ A ʘ B

No. 7: ʘ A ʘ B

No. 8: ʘ A ʘ B

No. 9: ʘ A ʘ B

No.10: ʘ A ʘ B

Figure A-6: Field for the entry of the lottery decisions