# Supplementary Information

## Title

Preferences and beliefs about financial risk taking mediate the association between anterior insula activation and self-reported real-life stock trading

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## Supplementary Database

The data is deposited in the Harvard Dataverse and can be accessed via this link. It contains a ".zip" file with the questionnaire (Supplementary Document), as well as the Matlab scripts and regions of interests used in the study. Additionally, all the group-level SPM ".mat" files described in the fMRI contrast overview table (see Supplementary Tables S2 and S3) are included in the ".zip" file. Finally, both the behavioural experiments (investing paradigm and stock allocation task) are included, as well as the final data set and scripts used for the analysis (programmed in Stata v13.1).
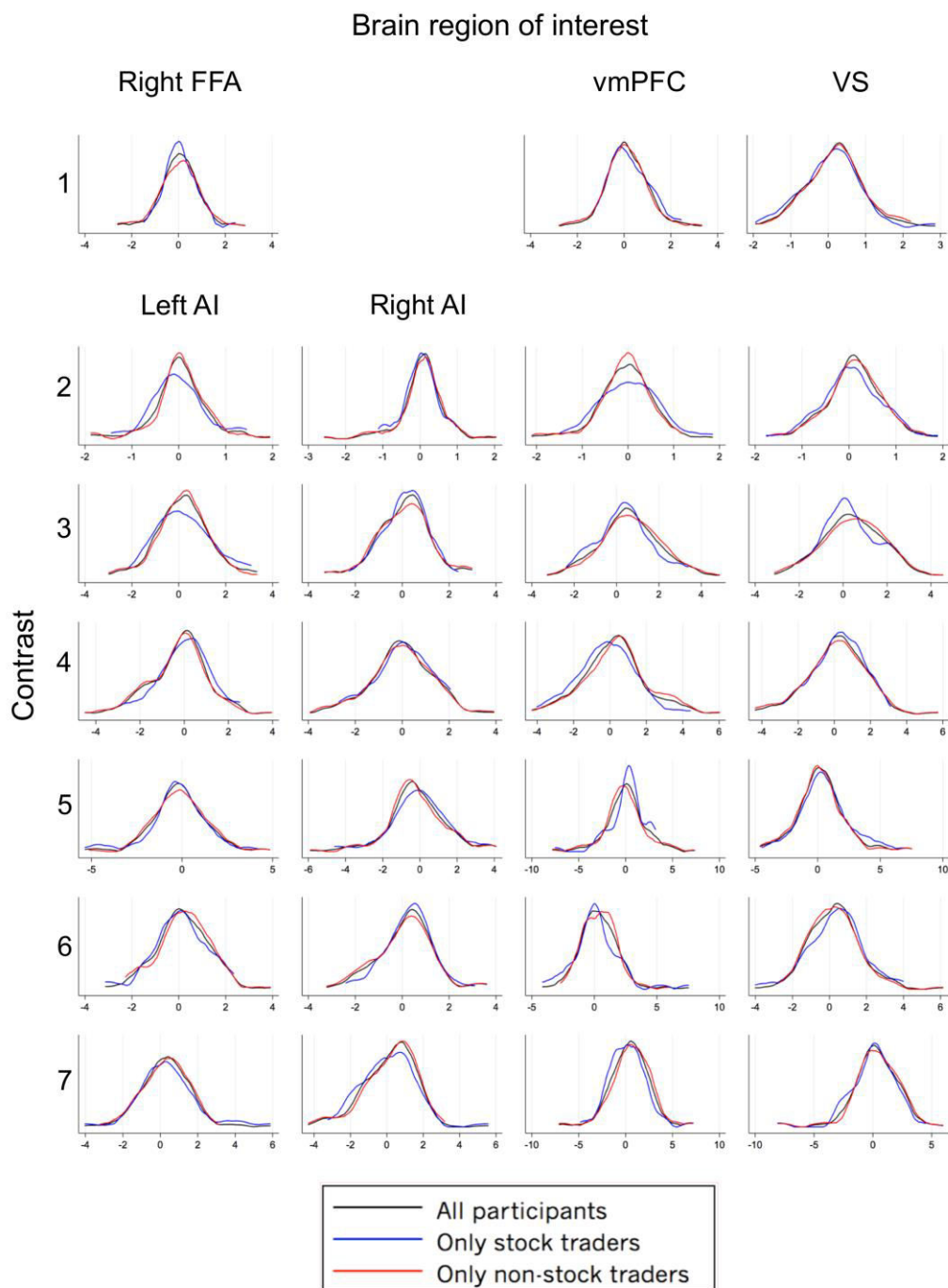
## Supplementary Document

This document is the questionnaire that was used to obtain the demographic, risk preference, as well as financial knowledge variables. It is included in the Supplementary Database ".zip" file, provided via this link.
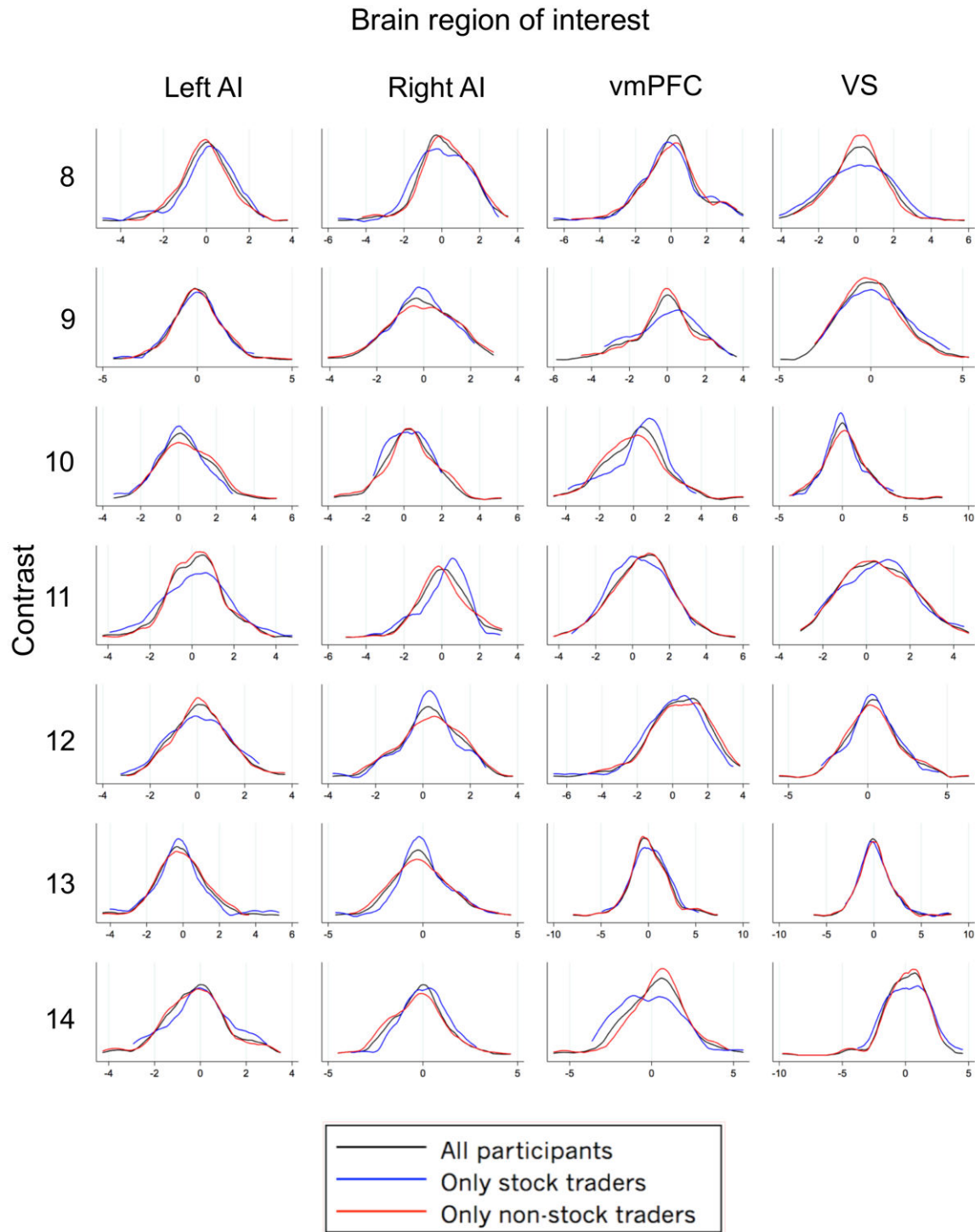
## Supplementary References

1.    Hayes, A. F. Miscellaneous topics in mediation analysis. in *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach* 165–207 (Guilford Press, 2013).
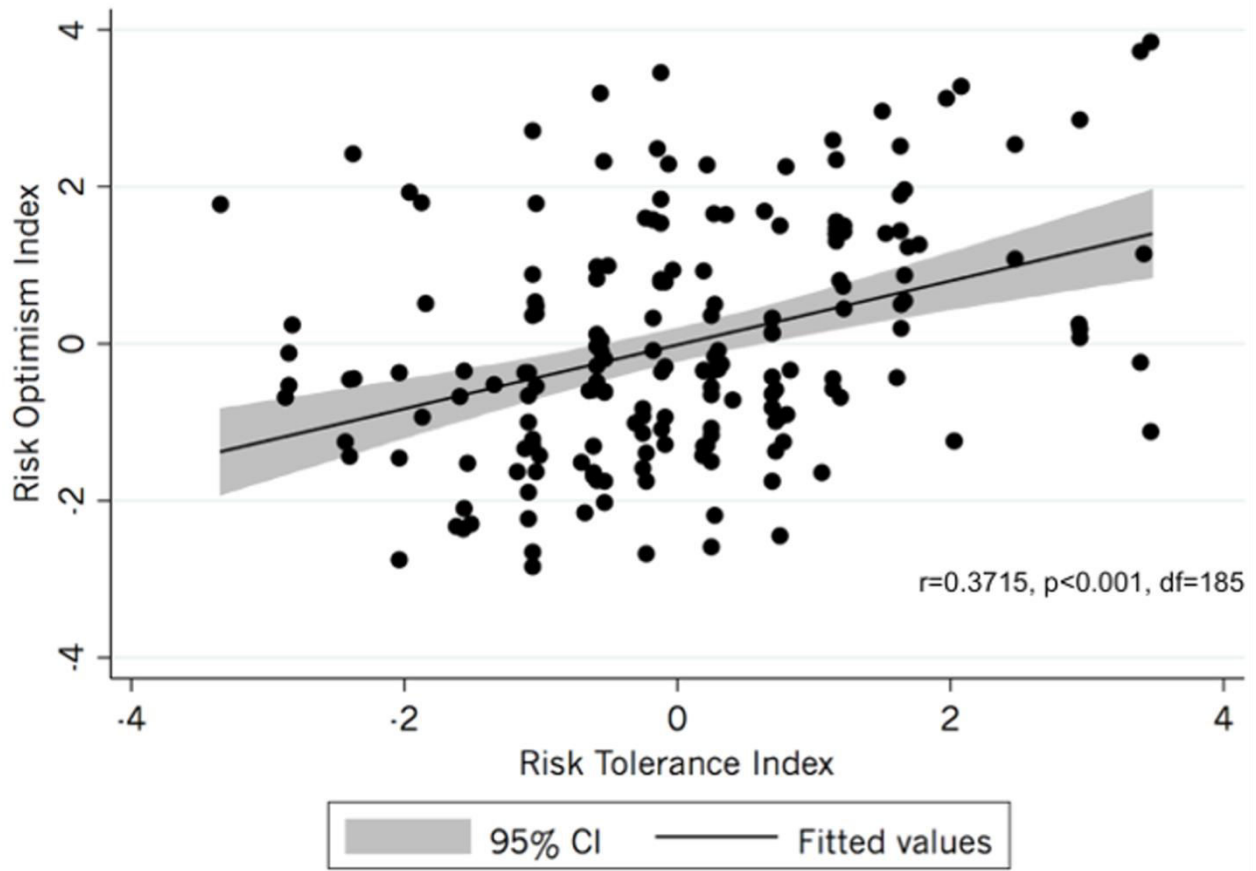
# Supplementary Figures



**Supplementary Figure S1.** Distribution plots of the extracted weighted beta estimates that were not found to be significantly associated with active stock trading (Supplementary Table S4). Here: Contrasts 1 to 7. Each contrast number refers to the contrast number shown in Supplementary Table S4, i.e. contrast 1 = Stock vs. Bond choice (gain domain). Please note that the right FFA was only used for the first contrast as a control variable. Abbreviations: AI: anterior insula; FFA: fusiform face area; vmPFC: ventromedial prefrontal cortex; VS: ventral striatum.

# Brain region of interest



**Supplementary Figure S2.** Distribution plots of the extracted weighted beta estimates that were not found to be significantly associated with active stock trading (Supplementary Table S4). Here: Contrasts 8 to 14. Each contrast number refers to the contrast number shown in Supplementary Table S4, i.e. contrast 11 = Good feedback after stock choice vs. Bad feedback after bond choice (gain domain). Abbreviations: AI: anterior insula; vmPFC: ventromedial prefrontal cortex; VS: ventral striatum.

r=0.3715, p<0.001, df=185

**Supplementary Figure S3. Correlation of risk tolerance and risk optimism.** The Risk Tolerance Index (RTI) and the Risk Optimism Index (ROI) were the first components of the principal component analyses (Supplementary Tables S8 and S9) using variables that significantly explained parts of the variance of active stock trading (Supplementary Tables S6 and S7).

**Supplementary Figure S4. Timeline of the behavioural stock allocation task.** Each subject was asked to make ten independent financial investment decisions by splitting up 23€ into a risky (stock) and a riskless (bond) option. The average amount of money invested into the stock was taken as a measure of financial risk preference.

# Supplementary Tables

Supplementary Table S1. General linear model designed for assessing reward prediction error activation in the investing task.

| Regressor number and onset | Parametric modulation | Duration |
|---|---|---|
| 1. Stock choice | n.a. | Stick function |
| 2. Bond choice | n.a. | Stick function |
| 3. & 4. & 5. & 6. Payoff feedback after stock choice | RPE, RP, and trial payoff | Stick function |
| 7. & 8. & 9. & 10. Payoff feedback after bond choice | RPE, RP, and trial payoff | Stick function |
| 11. Stock estimation after stock choice | n.a. | Stick function |
| 12. Stock estimation after bond choice | n.a. | Stick function |
| 13. Current payoff status after stock choice | n.a. | Stick function |
| 14. Current payoff status after bond choice | n.a. | Stick function |
| 15. - 20. Six movement regressors | n.a. | n.a. |
| 21. Constant | n.a. | n.a. |

Abbreviations: n.a. = not applicable; RPE = Reward Prediction Error (calculated as the difference between the updated objective probability of the stock being good at the time of the newly presented payoff feedback and the objective probability of the stock being good at the time before the new payoff feedback was presented), RP = Reward Prediction (calculated as the objective probability of the stock being good).

Supplementary Table S2. General linear model and contrast specification designed for assessing risk-related brain activation in the investing task.

| Regressor number and onset | Parametric modulation | Duration |
|---|---|---|
| 1. Stock choice in gain domain | n.a. | Time until button press |
| 2. Bond choice in gain domain | n.a. | Time until button press |
| 3. Stock choice in loss domain | n.a. | Time until button press |
| 4. Bond choice in loss domain | n.a. | Time until button press |
| 5. & 6. Good payoff feedback after stock choice in gain domain | Trial payoff | Stick function |
| 7. & 8. Bad payoff feedback after stock choice in gain domain | Trial payoff | Stick function |
| 9. & 10. Good payoff feedback after bond choice in gain domain | Trial payoff | Stick function |
| 11. & 12. Bad payoff feedback after bond choice in gain domain | Trial payoff | Stick function |
| 13. & 14. Good payoff feedback after stock choice in loss domain | Trial payoff | Stick function |
| 15. & 16. Bad payoff feedback after stock choice in loss domain | Trial payoff | Stick function |
| 17. & 18. Good payoff feedback after bond choice in loss domain | Trial payoff | Stick function |
| 19. & 20. Bad payoff feedback after bond choice in loss domain | Trial payoff | Stick function |
| 21. Stock estimation in gain domain | n.a. | Stick function |
| 22. Stock estimation in loss domain | n.a. | Stick function |
| 23. Current payoff status in gain domain | n.a. | Stick function |
| 24. Current payoff status in loss domain | n.a. | Stick function |
| 25. - 30. Six movement regressors | n.a. | n.a. |
| 31. Constant | n.a. | n.a. |

Abbreviations: n.a. = not applicable

Supplementary Table S3. Brain activation in the investing task (voxel-wise inclusion threshold, p(FWE)<0.05, k>10, n = 165), estimated using the GLM described in Supplementary Table S2.

| Contrast name | Region | Laterality | MNI coordinates | | | Cluster size | T | Cluster p(FWE-corrected) |
|---|---|---|---|---|---|---|---|---|
| | | | x | y | z | | | |
| Stock vs. Bond choice (gain domain) | Sensorimotor cortex | R | 39 | -19 | 53 | 100 | 5.81 | <0.001 |
| | Visual cortex | L | -12 | -97 | 8 | 15 | 5.19 | 0.003 |
| Bond vs. Stock choice (gain domain) | No activation below significance threshold | | | | | | | |
| Stock vs. Bond choice (loss domain) | No activation below significance threshold | | | | | | | |
| Bond vs. Stock choice (loss domain) | Sensorimotor cortex | L | -36 | -22 | 62 | 26 | 5.63 | <0.001 |
| Good vs. Bad payoff feedback after stock choice (gain domain) | Visual cortex | R | 24 | -94 | 8 | 963 | 8.33 | <0.001 |
| | Sensorimotor cortex | L | -42 | -25 | 50 | 368 | 7.75 | <0.001 |
| | Ventromedial prefrontal cortex | L/R | -6 | 38 | -10 | 179 | 6.72 | <0.001 |
| | Superior/ middle frontal gyrus /BA8 | L | -15 | 29 | 50 | 70 | 6.55 | <0.001 |
| | Supplementary motor area | L | -3 | -4 | 53 | 39 | 6.10 | <0.001 |
| | Thalamus | R | 12 | -10 | -4 | 19 | 6.06 | 0.001 |
| | Orbital part of the inferior frontal gyrus | R | 30 | 32 | -10 | 20 | 5.47 | 0.001 |
| | Middle frontal gyrus/BA9 | L | -30 | 41 | 32 | 10 | 5.26 | 0.005 |
| Bad vs. Good payoff feedback after stock choice (gain domain) | No activation below significance threshold | | | | | | | |
| Good vs. Bad payoff feedback after stock choice (loss domain) | No activation below significance threshold | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bad vs. Good payoff feedback after stock choice (loss domain) | No activation below significance threshold | | | | | | | |
| Good vs. Bad payoff feedback after bond choice (gain domain) | No activation below significance threshold | | | | | | | |
| Bad vs. Good payoff feedback after bond choice (gain domain) | No activation below significance threshold | | | | | | | |
| Good vs. Bad payoff feedback after bond choice (loss domain) | Visual cortex | R | | 24 | -94 | 5 | 173 | 9.06 | <0.001 |
| | Visual cortex | L | | -18 | -94 | -7 | 114 | 7.14 | <0.001 |
| | Anterior cingulate cortex | L | | -9 | 35 | 2 | 10 | 5.21 | 0.005 |
| Bad vs. Good payoff feedback after bond choice (loss domain) | No activation below significance threshold | | | | | | | |
| Good feedback after stock choice vs. Good feedback after bond choice (gain domain) | No activation below significance threshold | | | | | | | |
| Good feedback after bond choice vs. Good feedback after stock choice (gain domain) | No activation below significance threshold | | | | | | | |
| Good feedback after stock choice vs. Good feedback after bond choice (loss domain) | No activation below significance threshold | | | | | | | |
| Good feedback after bond choice vs. Good feedback after stock choice (loss domain) | Visual cortex | R | | 21 | -97 | 8 | 22 | 6.22 | 0.001 |
| Bad feedback after stock choice vs. Bad feedback after bond choice (gain domain) | No activation below significance threshold | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bad feedback after bond choice vs. Bad feedback after stock choice (gain domain) | Sensorimotor cortex | L | -42 | -22 | 50 | 126 | 5.95 | <0.001 |
| | Visual cortex | R | 24 | -94 | 5 | 20 | 5.8 | 0.001 |
| | Angular gyrus | R | 54 | -52 | 23 | 41 | 5.75 | <0.001 |
| | Angular gyrus | L | -42 | -64 | 35 | 87 | 5.38 | <0.001 |
| | Precuneus | R | 3 | -55 | 35 | 25 | 5.26 | 0.001 |
| | Opercular and triangular part of the inferior frontal gyrus | L | 39 | 17 | 29 | 37 | 5.19 | <0.001 |
| Bad feedback after stock choice vs. Bad feedback after bond choice (loss domain) | Insula | L | -42 | 5 | -1 | 24 | 5.4 | 0.001 |
| | Visual cortex | R | 21 | -97 | 5 | 21 | 5.37 | 0.001 |
| Bad feedback after bond choice vs. Bad feedback after stock choice (loss domain) | Angular gyrus | L | -45 | -64 | 38 | 34 | 5.23 | <0.001 |
| Good feedback after stock choice vs. Bad feedback after bond choice (gain domain) | Ventral striatum | L | -18 | 5 | -7 | 12 | 6.57 | 0.003 |
| | Ventral striatum | R | 21 | 5 | -10 | 19 | 6.19 | 0.001 |
| | Ventromedial prefrontal cortex | R | 9 | 38 | -10 | 12 | 5.5 | 0.003 |
| Bad feedback after bond choice vs. Good feedback after stock choice (gain domain) | Angular gyrus | R | 57 | -52 | 23 | 22 | 5.58 | 0.001 |
| Good feedback after stock choice vs. Bad feedback after bond choice (loss domain) | No activation below significance threshold | | | | | | | |
| Bad feedback after bond choice vs. Good feedback after stock choice (loss domain) | No activation below significance threshold | | | | | | | |
| Good feedback after bond choice vs. Bad feedback after stock choice | Sensorimotor activation | L | -42 | -22 | 59 | 65 | 5.87 | <0.001 |
| | Superior frontal | L | -15 | 32 | 50 | 10 | 5.18 | 0.005 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (gain domain) | gyrus/BA8 | | | | | | | |
| | Opercular part of the inferior frontal gyrus | R | 39 | 14 | 35 | 11 | 5.00 | 0.004 |
| | Precuneus | L/R | 0 | -55 | 38 | 15 | 4.93 | 0.002 |
| Bad feedback after stock choice vs. Good feedback after bond choice (gain domain) | No activation below significance threshold | | | | | | | |
| Good feedback after bond choice vs. Bad feedback after stock choice (loss domain) | Angular gyrus | L | -51 | -61 | 26 | 27 | 5.17 | 0.001 |
| Bad feedback after stock choice vs. Good feedback after bond choice (loss domain) | No activation below significance threshold | | | | | | | |

Region names based on the automatic anatomic labeling (aal) atlas. BA: Brodmann Area; L: Left; R: Right. Please note: the contrast of the parametrical modulators vs. baseline did not yield any activation below the significance threshold and are thus not included in the table.

Supplementary Table S4. Mean extracted weighted beta estimates of non-active stock traders (NAST, n = 109) and active stock traders (AST, n = 48). Standard error in parentheses. The only two significant two-sample t-test results (p<0.05, uncorrected) are shown in bold and were p=0.0264 for the left AI (L AI) and p=0.0072 for the right AI (R AI).

| Contrast number | Contrast description | Region of interest | NAST Mean (SE) | AST Mean (SE) |
|---|---|---|---|---|
| 1 | Stock vs. Bond choice (gain domain) | **L AI** | **-0.06 (±0.058)** | **-0.31 (±0.103)** |
| | | **R AI** | **0.02 (±0.066)** | **-0.31 (±0.105)** |
| | | vmPFC | 0.08 (±0.089) | 0.24 (±0.124) |
| | | VS | 0.20 (±0.073) | 0.07 (±0.119) |
| | | R FFA | 0.05 (±0.085) | 0.10 (±0.102) |
| 2 | Stock vs. Bond choice (loss domain) | L AI | 0.07 (±0.056) | -0.02 (±0.087) |
| | | R AI | 0.07 (±0.060) | 0.02 (±0.066) |
| | | vmPFC | -0.08 (±0.055) | 0.03 (±0.096) |
| | | VS | 0.12 (±0.057) | 0.07 (±0.096) |
| 3 | Good vs. Bad payoff feedback after stock choice (gain domain) | L AI | 0.18 (±0.102) | 0.29 (±0.178) |
| | | R AI | 0.10 (±0.115) | 0.14 (±0.133) |
| | | vmPFC | 0.72 (±0.136) | 0.36 (±0.188) |
| | | VS | 0.50 (±0.134) | 0.32 (±0.167) |
| 4 | Good vs. Bad payoff feedback after stock choice (loss domain) | L AI | -0.29 (±0.125) | 0.02 (±0.172) |
| | | R AI | -0.04 (±0.129) | 0.04 (±0.172) |
| | | vmPFC | 0.39 (±0.174) | -0.20 (±0.233) |
| | | VS | 0.12 (±0.161) | 0.24 (±0.197) |
| 5 | Good vs. Bad payoff feedback after bond choice (gain domain) | L AI | -0.07 (±0.143) | -0.25 (±0.246) |
| | | R AI | -0.16 (±0.152) | -0.03 (±0.239) |
| | | vmPFC | -0.09 (±0.214) | 0.13 (±0.280) |
| | | VS | 0.17 (±0.191) | 0.58 (±0.307) |
| 6 | Good vs. Bad payoff feedback after bond choice (loss domain) | L AI | 0.25 (±0.107) | 0.08 (±0.172) |
| | | R AI | 0.11 (±0.120) | 0.29 (±0.146) |
| | | vmPFC | 0.42 (±0.134) | 0.18 (±0.292) |
| | | VS | 0.24 (±0.130) | 0.33 (±0.222) |
| 7 | Good feedback after stock choice vs. Good feedback after bond choice (gain domain) | L AI | 0.27 (±0.114) | 0.42 (±0.238) |
| | | R AI | 0.21 (±0.137) | 0.08 (±0.220) |
| | | vmPFC | 0.65 (±0.209) | 0.19 (±0.290) |
| | | VS | 0.35 (±0.196) | 0.04 (±0.293) |
| 8 | Good feedback after stock choice vs. Good feedback after bond choice (loss domain) | L AI | -0.06 (±0.113) | -0.01 (±0.205) |
| | | R AI | 0.23 (±0.135) | -0.04 (±0.213) |
| | | vmPFC | 0.01 (±0.167) | -0.12 (±0.271) |
| | | VS | 0.13 (±0.142) | 0.05 (±0.257) |
| 9 | Bad feedback after stock choice vs. Bad feedback after bond choice (gain domain) | L AI | 0.02 (±0.133) | -0.11 (±0.200) |
| | | R AI | -0.06 (±0.138) | -0.08 (±0.166) |
| | | vmPFC | -0.16 (±0.151) | -0.04 (±0.239) |
| | | VS | 0.03 (±0.162) | 0.30 (±0.258) |

| | | | | |
|---|---|---|---|---|
| 10 | Bad feedback after stock choice vs. Bad feedback after bond choice (loss domain) | L AI | 0.49 (±0.134) | 0.05 (±0.183) |
| | | R AI | 0.38 (±0.138) | 0.20 (±0.143) |
| | | vmPFC | 0.04 (±0.183) | 0.26 (±0.246) |
| | | VS | 0.26 (±0.188) | 0.14 (±0.232) |
| 11 | Good feedback after stock choice vs. Bad feedback after bond choice (gain domain) | L AI | 0.21 (±0.126) | 0.18 (±0.245) |
| | | R AI | 0.05 (±0.135) | 0.06 (±0.192) |
| | | vmPFC | 0.56 (±0.161) | 0.33 (±0.212) |
| | | VS | 0.53 (±0.155) | 0.62 (±0.239) |
| 12 | Good feedback after stock choice vs. Bad feedback after bond choice (loss domain) | L AI | 0.20 (±0.115) | 0.07 (±0.186) |
| | | R AI | 0.34 (±0.124) | 0.24 (±0.178) |
| | | vmPFC | 0.43 (±0.167) | 0.06 (±0.270) |
| | | VS | 0.37 (±0.170) | 0.38 (±0.223) |
| 13 | Good feedback after bond choice vs. Bad feedback after stock choice (gain domain) | L AI | -0.09 (±0.129) | -0.13 (±0.248) |
| | | R AI | -0.11 (±0.146) | 0.05 (±0.208) |
| | | vmPFC | 0.07 (±0.211) | 0.17 (±0.278) |
| | | VS | 0.15 (±0.184) | 0.28 (±0.280) |
| 14 | Good feedback after bond choice vs. Bad feedback after stock choice (loss domain) | L AI | -0.24 (±0.136) | 0.03 (±0.198) |
| | | R AI | -0.27 (±0.144) | 0.09 (±0.197) |
| | | vmPFC | 0.38 (±0.176) | -0.08 (±0.283) |
| | | VS | -0.01 (±0.172) | 0.19 (±0.247) |

AI: anterior insula; FFA: fusiform face area; L: left; R: right; vmPFC: ventromedial prefrontal cortex; VS: ventral striatum.

Supplementary Table S5. Descriptive statistics of the variables that were used to create the indices of risk optimism and risk tolerance.

| Risk optimism | Mean | SD | Min | Max | N | Q# |
|---|---|---|---|---|---|---|
| Self-assessment of financial knowledge | 4.4 | 1.3 | 1 | 7 | 198 | 32a |
| Self-assessment of mathematical abilities | 4.8 | 1.3 | 1 | 7 | 197 | 32b |
| Believing that speculation is a useful way to increase money | 2.0 | 1.0 | 1 | 4 | 196 | 30f |
| Trusting your own financial expertise | 2.5 | 0.8 | 1 | 4 | 196 | 30c |
| Thoroughly checking the theoretical probabilities before making financial investments to avoid mistakes | 3.2 | 0.8 | 1 | 4 | 196 | 30b |
| Behavioural risk optimism in the investing paradigm | 0.6 | 5.5 | -18.8 | 19.4 | 189 | n.a. |
| Risk Optimism Index (ROI) | 0.0 | 1.4 | -3.1 | 3.7 | 195 | n.a. |
| *Risk tolerance* | | | | | | |
| Self-assessment of financial risk taking | 3.4 | 1.4 | 1 | 7 | 196 | 29b |
| Self-assessment of risk taking when trusting strangers | 4.0 | 1.5 | 1 | 7 | 196 | 29f |
| Risk taking in the hypothetical lottery question | 1.4 | 1.4 | 0 | 5 | 198 | 38 |
| Liking the excitement of risks | 2.2 | 0.9 | 1 | 4 | 196 | 30a |
| Feeling that the urge to win outweighs the fear to lose | 2.1 | 0.9 | 1 | 4 | 196 | 30d |
| Feeling psychologically pressured due to financial risks | 2.3 | 0.9 | 1 | 4 | 195 | 30e |
| Behavioural risk taking in the investing paradigm | 57.5 | 26.5 | 0.0 | 100.0 | 189 | n.a. |
| Behavioural risk taking in the stock allocation task | 11.2 | 4.4 | 0.4 | 23.0 | 193 | n.a. |
| Risk Tolerance Index (RTI) | 0.0 | 1.4 | -2.7 | 3.5 | 187 | n.a. |

Q# = number in financial, risk preference, and personality questionnaire, provided as a Supplementary Document. n.a. = not applicable

Supplementary Table S6. Logistic regression results of active stock trading including risk optimism-related measures and the Risk Optimism Index (ROI).

| | Active stock trading | | | | | | |
|---|---|---|---|---|---|---|---|
| Self-assessment of financial knowledge | 4.09*** (0.274) | | | | | | |
| Self-assessment of mathematical abilities | | -0.26 (0.120) | | | | | |
| Believing that speculation is a useful way to increase money | | | 6.24*** (0.882) | | | | |
| Trusting your own financial expertise | | | | 3.54*** (0.477) | | | |
| Thoroughly checking the theoretical probabilities before making financial investments to avoid mistakes | | | | | -1.78* (0.137) | | |
| Behavioural risk optimism in the investing paradigm | | | | | | 0.92 (0.030) | |
| Risk Optimism Index (ROI) | | | | | | | 5.30*** (0.340) |
| N | 198 | 197 | 196 | 196 | 196 | 189 | 196 |
| Pseudo $R^2$ | 0.0844 | 0.0003 | 0.2307 | 0.0586 | 0.0134 | 0.0037 | 0.1609 |

Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.001$. Z-values are shown with standard errors in parentheses.

Supplementary Table S7. Logistic regression results of active stock trading including risk tolerance-related measures and the Risk Tolerance Index (RTI).

| | Active stock trading | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Self-assessment of financial risk taking | 6.37*** (0.435) | | | | | | | | |
| Self-assessment risk taking when trusting strangers | | -1.96* (0.084) | | | | | | | |
| Risk taking in the hypothetical lottery question | | | 1.67* (0.135) | | | | | | |
| Liking the excitement of risks | | | | 2.22* (0.268) | | | | | |
| Feeling that the urge to win outweighs the fear to lose | | | | | 3.76*** (0.398) | | | | |
| Feeling psychologically pressured due to financial risks | | | | | | -2.65** (0.114) | | | |
| Behavioural risk taking in the investing paradigm | | | | | | | 1.79* (0.007) | | |
| Behavioural risk taking in the allocation paradigm | | | | | | | | -0.47 (0.036) | |
| Risk Tolerance Index (RTI) | | | | | | | | | 5.05*** (0.243) |
| N | 196 | 196 | 198 | 196 | 196 | 195 | 189 | 193 | 186 |
| Pseudo $R^2$ | 0.2531 | 0.0166 | 0.0117 | 0.0216 | 0.0653 | 0.0317 | 0.0148 | 0.0009 | 0.1363 |

Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.001$. Z-values are shown with standard errors in parentheses.

Supplementary Table S8. The principal component analysis results using four risk optimism variables (n = 196). The first component (CP1) was used as the Risk Optimism Index (ROI).

| | Factor loading | | | |
| --- | --- | --- | --- | --- |
| | CP1 | CP2 | CP3 | CP4 |
| Self-assessment of financial knowledge | 0.639 | 0.155 | -0.284 | 0.698 |
| Believing that speculation is a useful way to increase money | 0.424 | -0.470 | 0.774 | 0.032 |
| Trusting your own financial knowledge | 0.642 | 0.183 | -0.211 | -0.714 |
| Thoroughly checking the theoretical probabilities before to avoid mistakes | -0.021 | 0.850 | 0.525 | -0.044 |
| Eigenvalue | 1.92 | 1.12 | 0.68 | 0.28 |
| Proportion % | 47.9 | 28.1 | 17.1 | 0.1 |

Supplementary Table S9. The principal component analysis results using seven risk tolerance variables (n = 186). The first component (CP1) was used as the Risk Tolerance Index (RTI).

| | Factor loading | | | | | | |
|---|---|---|---|---|---|---|---|
| | CP1 | CP2 | CP3 | CP4 | CP5 | CP6 | CP7 |
| Self-assessment of financial risk taking | 0.554 | 0.125 | 0.089 | -0.140 | -0.008 | 0.108 | 0.799 |
| Self-assessment of risk taking when trusting strangers | 0.100 | -0.708 | -0.180 | 0.384 | 0.366 | 0.366 | 0.077 |
| Risk taking in the hypothetical lottery question | 0.394 | -0.051 | -0.218 | 0.617 | -0.506 | -0.388 | -0.085 |
| Feeling that the urge to win outweighs the fear to lose | 0.453 | -0.049 | 0.229 | -0.072 | 0.620 | -0.528 | -0.267 |
| Liking the excitement of risks | 0.466 | 0.024 | 0.452 | -0.086 | -0.267 | 0.530 | -0.467 |
| Feeling psychologically pressured due to financial risks | -0.310 | 0.102 | 0.740 | 0.539 | 0.082 | -0.042 | 0.218 |
| Behavioural risk taking in the investing paradigm | 0.094 | 0.684 | -0.328 | 0.387 | 0.384 | 0.33 | -0.108 |
| Eigenvalue | 2.22 | 1.23 | 0.92 | 0.85 | 0.73 | 0.64 | 0.42 |
| Proportion % | 31.7 | 17.5 | 13.1 | 12.1 | 10.4 | 9.1 | 6.0 |

Supplementary Table S10. Mediation models investigating the mediation of the brain activation in the left and right anterior insula (AI, both independent variables) to active stock trading (AST, dependent variable) through the risk tolerance and optimism indices (RTI and ROI, both mediators), as well as the financial Risk Seeking and Preference Index (RSPI, also a mediator). The Sobel-Goodman (SG) Mediation test was used with subsequent bootstrapping of the effect (all n = 157, seed set at 10, 10,000 repetitions). An effect is considered significant if the confidence interval does not include the null hypothesis (i.e. zero is not included).

| Pathway (IV → MV → DV) | a*b (indirect effect) | c (total effect) | c' (direct effect) | mediation[1] (indirect to total) |
|---|---|---|---|---|
| l.AI → RTI → AST | -0.08 (-0.145 to -0.028) | -0.13 (-0.240 to -0.001) | -0.05 (-0.157 to 0.075) | 0.64 (≥0.177) |
| l.AI → ROI → AST | -0.07 (-0.116 to -0.035) | -0.13 (-0.240 to -0.001) | -0.06 (-0.162 to 0.064) | 0.56 (≥0.229) |
| r.AI → RTI → AST | -0.07 (-0.121 to -0.032) | -0.14 (-0.238 to -0.030) | -0.07 (-0.156 to 0.029) | 0.52 (≥0.250) |
| l.AI → RSPI → AST | -0.11 (-0.176 to -0.050) | -0.13 (-0.240 to -0.001) | -0.02 (-0.123 to 0.098) | 0.86 (≥0.353) |
| r.AI → RSPI → AST | -0.08 (-0.137 to -0.030) | -0.14 (-0.238 to -0.030) | -0.06 (-0.135 to 0.031) | 0.59 (≥0.305) |

Observed coefficients are shown with 95% (bias-corrected and accelerated) confidence intervals in parentheses.

[1]Please note that the full confidence intervals for the mediation (indirect to total) effect were not included, given that this measure can exceed the reasonable values (i.e. ≤1.00) and has to be taken with caution[1]. We thus only included the fact that the 95% confidence interval remains positive and does not include zero, thus implying a significant mediation effect. Please note that in all cases, a switch of the mediator and independent variables resulted in no significant mediation.

Supplementary Table S11. Pairwise correlations (uncorrected) of the latent variables measured in the experiment, meant as a sanity check. Here: Intelligence and the stock assessment error in the investing paradigm.

| | Figural intelligence | Numerical intelligence | Verbal intelligence | Stock assessment error |
|---|---|---|---|---|
| Figural intelligence | | 0.432*** | 0.278** | -0.216** |
| | | 196 | 196 | 189 |
| Numerical intelligence | | | 0.432*** | -0.153** |
| | | | 196 | 189 |
| Verbal intelligence | | | | -0.308*** |
| | | | | 189 |
| Stock assessment error | | | | |

Coefficients r and number of observations shown. Significance levels: *p<0.1, **p<0.05, ***p<0.001.

Supplementary Table S12. The principal component analysis results using the significant variables from both the risk optimism and the risk tolerance category (n = 186). The first component (CP1) was used as the financial Risk Seeking and Preference Index (RSPI).

| | Factor loading | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CP1 | CP2 | CP3 | CP4 | CP5 | CP6 | CP7 | CP8 | CP9 | CP10 | CP11 |
| Self-assessment of financial risk taking | 0.479 | -0.120 | -0.084 | 0.047 | 0.109 | -0.093 | 0.008 | 0.027 | 0.191 | -0.779 | -0.287 |
| Self-assessment of risk taking when trusting strangers | 0.007 | -0.371 | 0.586 | -0.233 | -0.220 | 0.404 | 0.275 | 0.041 | 0.420 | 0.007 | 0.016 |
| Risk taking in the hypothetical lottery question | 0.278 | -0.161 | 0.104 | 0.502 | -0.316 | 0.471 | -0.402 | 0.030 | -0.374 | -0.018 | 0.105 |
| Feeling that the urge to win outweighs the fear to lose | 0.300 | -0.342 | -0.117 | 0.195 | 0.156 | -0.071 | 0.691 | 0.228 | -0.363 | 0.226 | -0.023 |
| Liking the excitement of risks | 0.358 | -0.190 | -0.041 | 0.034 | 0.452 | 0.098 | -0.147 | -0.661 | 0.202 | 0.345 | -0.034 |
| Feeling psychologically pressured due to financial risks | -0.246 | 0.097 | -0.221 | 0.014 | 0.595 | 0.643 | 0.015 | 0.307 | 0.060 | -0.118 | 0.024 |
| Behavioural risk taking in the investing paradigm | 0.132 | 0.246 | -0.596 | -0.027 | -0.482 | 0.329 | 0.317 | -0.214 | 0.272 | 0.039 | 0.063 |
| Self-assessment of financial knowledge | 0.336 | 0.469 | 0.289 | -0.152 | 0.141 | 0.028 | 0.175 | -0.091 | -0.159 | -0.175 | 0.668 |
| Believing that speculation is a useful way to increase money | 0.418 | 0.006 | -0.123 | -0.005 | 0.017 | -0.158 | -0.285 | 0.590 | 0.445 | 0.346 | 0.193 |
| Trusting your own financial knowledge | 0.282 | 0.548 | 0.265 | -0.130 | -0.011 | 0.165 | 0.044 | 0.093 | -0.143 | 0.238 | -0.646 |
| Thoroughly checking the theoretical probabilities before to avoid mistakes | -0.172 | 0.282 | 0.227 | 0.782 | 0.071 | -0.131 | 0.224 | -0.047 | 0.391 | 0.001 | -0.013 |
| Eigenvalue | 2.99 | 1.67 | 1.13 | 0.95 | 0.91 | 0.86 | 0.70 | 0.64 | 0.53 | 0.36 | 0.25 |
| Proportion % | 27.2 | 15.2 | 10.2 | 8.7 | 8.3 | 7.8 | 6.4 | 5.8 | 4.9 | 3.3 | 2.3 |

Supplementary Table S13. Linear and multiple regression results of active stock trading including activation in the left anterior insula and the financial Risk Seeking and Preference Index (RSPI). Coefficients are shown with t-statistics in parentheses.

| | Active stock trading | | | |
|---|---|---|---|---|
| Left AI (stock > bond choice, gain domain) | -0.13 | -0.13 | -0.10 | 0.0002 |
| | (-2.24)** | (-2.39)** | (-1.93)* | (0.00) |
| Household income (after taxes) | | 0.10 | 0.09 | 0.06 |
| | | (4.72)*** | (4.54)*** | (3.72)*** |
| Having financial liabilities | | -0.11 | -0.12 | -0.11 |
| | | (-1.54) | (-1.60) | (-1.77)* |
| Years of education | | | 0.03 | 0.02 |
| | | | (1.78)* | (1.70)* |
| Financial literacy | | | 0.04 | -0.03 |
| | | | (0.41) | (-0.35) |
| Debt literacy | | | -0.01 | -0.10 |
| | | | (-0.16) | (-1.57) |
| Numeracy | | | -0.10 | -0.04 |
| | | | (-0.81) | (-0.40) |
| Verbal intelligence | | | 0.003 | 0.004 |
| | | | (0.64) | (0.98) |
| Numerical intelligence | | | 0.0003 | 0.001 |
| | | | (0.07) | (0.26) |
| Figural intelligence | | | -0.01 | -0.01 |
| | | | (-1.99)** | (-2.08)** |
| Financial Risk Seeking and Preference Index (RSPI) | | | | 0.14 |
| | | | | (7.86)*** |
| N | 157 | 157 | 157 | 157 |
| Adjusted R$^2$ | 0.03 | 0.15 | 0.16 | 0.41 |

Significance levels: *p<0.1, **p<0.05, ***p<0.001.

Supplementary Table S14. Linear and multiple regression results of active stock trading including activation in the right anterior insula and the financial Risk Seeking and Preference Index (RSPI). Coefficients are shown with t-statistics in parentheses.

| | Active stock trading | | | |
|---|---|---|---|---|
| Right AI (stock > bond choice, gain domain) | -0.14 | -0.15 | -0.14 | -0.06 |
| | (-2.72)** | (-3.14)** | (-2.85)** | (-1.41) |
| Household income (after taxes) | | 0.10 | 0.09 | 0.07 |
| | | (4.84)*** | (4.68)*** | (3.88)*** |
| Having financial liabilities | | -0.13 | -0.14 | -0.12 |
| | | (-1.83)* | (-1.87)* | (-1.86)* |
| Years of education | | | 0.03 | 0.02 |
| | | | (1.90)* | (1.79)* |
| Financial literacy | | | 0.03 | -0.03 |
| | | | (0.39) | (-0.35) |
| Debt literacy | | | -0.01 | -0.09 |
| | | | (-0.12) | (-1.43) |
| Numeracy | | | -0.08 | -0.03 |
| | | | (-0.69) | (-0.26) |
| Verbal intelligence | | | 0.004 | 0.004 |
| | | | (0.76) | (0.97) |
| Numerical intelligence | | | 0.0004 | 0.001 |
| | | | (0.11) | (0.24) |
| Figural intelligence | | | -0.01 | -0.007 |
| | | | (-1.96)* | (-1.95)* |
| Financial Risk Seeking and Preference Index (RSPI) | | | | 0.13 |
| | | | | (7.66)*** |
| N | 157 | 157 | 157 | 157 |
| Adjusted $R^2$ | 0.04 | 0.17 | 0.19 | 0.42 |

Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.001$.