Cognition and the Placebo Effect
– Supporting Information –

General Instruction

Two possible explanations for the absence of an expectancy effect in objective measures in our main experiment concern (1) the type of task that was used, i.e., maybe such effects appear only in higher cognitive functions such as tasks based on working memory, instead of simple reaction time tasks, and (2) the expectancy manipulation itself. To pursue these questions, we conducted two follow-up experiments that employed specific arithmetic tasks which heavily rely on working memory capacity and were already successfully introduced in research on stereotype threat [26-27]. Moreover, we used two different expectancy manipulations: in the first experiment, we told participants that specific body postures would enhance or impair cognitive performance, respectively, via a body feedback process. In the second experiment, we used a more direct approach by pretending to administer a cognitive enhancer or a saline solution to the participants, when in reality both probes contained saline solution.

Follow-up Experiment I

Materials and Methods

Participants

We recruited 41 individuals (24 female; mean age 26.39 years ± 0.83 SE_m; mean age [female participants] 26.63 years ± 1.19 SE_m; mean age [male participants] 26.06 years ± 1.14 SE_m). All participants received payment as compensation. Exclusion criteria involved neurological or neuropsychiatric diseases, current medication, or substance abuse. The study was approved by the Ethics Committee of the Medical Council of Hamburg and all participants gave written consent in accordance with the Declaration of Helsinki.

Expectancy Manipulation

Participants were informed at the beginning of the experiment that they would take part in a study investigating body posture feedback on cognitive performance. Half of the participants were instructed that a tense body posture would increase cognitive performance (placebo condition), whereas a relaxed body posture would decrease cognitive performance (nocebo condition) via body feedback mechanisms. The other half of the participants were instructed that
a relaxed body posture would lead to better cognitive performance (placebo condition), whereas
a tense body posture would impair cognitive performance (nocebo condition). Instructions were
randomized across participants.

**Experimental Procedure**

As dependent variables, we measured reaction times (RTs) and success rates (SRs) in
a modular arithmetic task adapted from the literature on stereotype threat [26]. This task was
shown to be sensitive to stereotype-relevant instructions and relies heavily on working memory
capacity [26]. Participants saw equations on the screen and had to decide whether or not the
equation was correct. Equations were created in three difficulty levels (easy, medium, hard). To
assure a high motivation throughout the experiment, we instructed the participants at the very
beginning that the amount of money they would receive for study compensation would be
increased proportionally to their performance across all experimental blocks.

All participants first completed a short introductory block of 12 trials (4 easy, 4 medium, 4
hard; 6 correct, 6 incorrect) to become acquainted with the task. Control of the experimental
timing and the stimulus presentation throughout the experiment was achieved using
Presentation 16.4, NeuroBehavioral Systems (Albany, CA, USA). Each trial started with a
fixation cross presented on a computer screen for 500ms, followed by an equation. The
equation was presented until participants responded with a button press. Half of the participants
were instructed to respond with the left arrow key on the computer keyboard when the equation
was correct and with the right arrow key if the equation was incorrect, whereas the other half
was instructed with the opposite mapping. A feedback screen was shown for 1000ms informing
them if their answer had been correct or not. The next trial started after an inter-trial interval of
1000ms.

After the introductory block, participants completed two test blocks, one test block in the
placebo, one in the nocebo condition. Condition order was randomized across participants.
Each test block consisted of 54 trials, 18 easy, 18 medium, and 18 hard; 27 equations were
correct, 27 were incorrect. No equations were repeated within a participant.

At the end of the experiment, participants were debriefed about the actual study purpose
and were asked to indicate on a 7-point scale whether they had believed the previous
instruction. Three participants (1 female) had to be excluded, because they did not believe our
expectancy manipulation.

**Behavioral data analyses**

Behavioral data were analyzed using SPSS 20 (IBM, Armonk, NY, USA). We calculated
SRs for each participant and the mean RT of all successfully completed trials for each
participant, separately for the placebo and nocebo conditions. The introductory block was not
included in the calculations. We then performed an ANOVA with the within-subjects factors
expectancy (placebo vs. nocebo) and difficulty (easy vs. medium vs. hard) for the RT and SR data and performed paired $t$-tests as follow-up analyses.

**Results**

The expectancy instruction did not have any significant effects on performance in the modular arithmetic task on any measure (SR: $F(1,37)=2.43$, $p=.128$; RT: $F(1,37)<1$; Fig. A). In contrast, the difficulty level had strong effects on both measures, i.e., the higher the difficulty level, the lower the SR and the slower the RT, irrespective of the expectancy condition (SR: $F(2,74)=44.51$, $p<.001$, $\eta^2_p=0.55$; RT: $F(2,74)=150.71$, $p<.001$, $\eta^2_p=0.80$, $\varepsilon=.614$, Greenhouse-Geisser corrected for violations of sphericity; Fig. A).

![Fig. A](image)

**Fig. A.** (A) SRs and (B) RTs for placebo and nocebo conditions in the modular arithmetics task of Follow-up Experiment I. No effects of expectancy emerged. Error bars indicate standard errors of paired differences [33]. The expectancy instruction did not have any significant effects on SRs or RTs, whereas the difficulty level had strong effects on both measures. No interaction of expectancy and difficulty emerged in either SRs or RTs.
All follow-up paired t-tests comparing SRs and RTs in the different difficulty levels were significant (all ps<.001). However, no interaction of expectancy and difficulty emerged in either SRs or RTs (SR: F(2,74)=2.00, p=.143; RT: F<1), indicating that the expectancy manipulation simply had no statistically valid effect on any objective measure (Fig. A).

Follow-up Experiment II

Materials and Methods

Participants

We recruited 37 individuals (17 female; mean age 25.44 years ± 0.85 SEM; mean age [female participants] 24.64 years ± 0.63 SEM; mean age [male participants] 26.10 years ± 1.42 SEM). All participants received payment as compensation. Exclusion criteria involved neurological or neuropsychiatric diseases, current medication, or substance abuse. The study was approved by the Ethics Committee of the Medical Council of Hamburg and all participants gave written consent in accordance with the Declaration of Helsinki.

Expectancy Manipulation

Participants were informed at the beginning of the experiment that they would take part in a study in which a cognitive enhancer, oxytocin, was used and applied via nasal sprays. We also informed them about diverse positive effects of oxytocin on cognitive performance. They were told that they would take part in three blocks, at first one short block without any medication, then one block with oxytocin (placebo condition) and one block with an inactive substance (control condition). The order of the expectancy conditions were randomized across participants. The nasal sprays were labeled accordingly, although all nasal sprays contained a saline solution, irrespective of labeling. When using the nasal sprays, all participants were instructed to spray four times, twice in each nostril, and to wait for 10 minutes after application before starting the experimental procedure to allow the “medication to become effective”. At least 40 minutes lay between each nasal spray application to allow the “medication to lose effectiveness” before applying the next nasal spray.

Experimental Procedure

As dependent variables, we measured reaction times (RTs) and success rates (SRs) in an arithmetic task including modular arithmetic and basic arithmetic tasks adapted from the literature on stereotype threat [26-27]. This task was shown to be sensitive to stereotype-relevant instructions and relies heavily on working memory capacity [26-27]. Participants saw equations on the screen and had to decide whether or not the equation was correct. Equations
Cognition and the Placebo Effect

were created in three difficulty levels (easy, medium, hard). To assure a high motivation throughout the experiment, we instructed the participants at the very beginning that the amount of money they would receive for study compensation would be increased proportionally to their performance across all experimental blocks.

All participants first completed one experimental phase without any medication application. It started with a short introductory block of 12 trials (4 easy, 4 medium, 4 hard; 6 correct, 6 incorrect), followed by a short training block of 16 trials (4 easy, 8 medium, 4 hard; 8 correct, 8 incorrect), and the actual test phase of 24 trials (8 easy, 8 medium, 8 hard; 12 correct, 12 incorrect). This was intended to get participants acquainted with the task and the block structure. After the training and after the test block, participants were given feedback about their performance.

Control of the experimental timing and the stimulus presentation throughout the experiment was achieved using Presentation 16.4, NeuroBehavioral Systems (Albany, CA, USA). Each trial started with a fixation cross presented on a computer screen for 500ms, followed by an equation. The equation was presented until participants responded with a button press, up to a maximum of 7000ms. Half of the participants were instructed to respond with the left arrow key on the computer keyboard when the equation was correct and with the right arrow key if the equation was incorrect, whereas the other half was instructed with the opposite mapping. The next trial started after an inter-trial interval of 1000ms.

After the first experimental phase, participants either first completed the oxytocin phase (placebo condition) and then the “inactive substance” phase (control condition) or vice versa; condition order was randomized across participants. The oxytocin phase started with a short introductory block of 6 trials (2 easy, 2 medium, 2 hard; 3 correct, 3 incorrect), followed by a training block of 16 trials (8 easy, 4 medium, 4 hard; 8 correct, 8 incorrect). To increase credibility of our previous instruction, we increased the amount of easy equations in this training block, and showed a higher overall performance during feedback after the training block by adding 12.5% to the participants’ actual success rate (up to a maximum of 94%). The subsequent test block consisted of 48 trials equally distributed across all difficulty levels (16 easy, 16 medium, 16 hard; 24 correct, 24 incorrect); feedback at the end of the test block, however, was again manipulated to improve the participants’ performance by 12.5% (up to a maximum of 96%). The “inactive substance” phase also started with a short introductory block of 6 trials (2 easy, 2 medium, 2 hard; 3 correct, 3 incorrect), followed by a training block of 16 trials (4 easy, 8 medium, 4 hard; 8 correct, 8 incorrect), and by a test block of 48 trials (16 easy, 16 medium, 16 hard; 24 correct, 24 incorrect). Feedback was again given at the end of the training and at the end of the test block, without any experimental manipulation. No equation in the training or test blocks was repeated within a participant.

At the end of the experiment, participants were debriefed about the actual study purpose and were asked to indicate on a 7-point scale whether they had believed the previous instruction. Nine participants (2 female) had to be excluded, because they did not believe our expectancy manipulation.
Behavioral data analyses

Behavioral data were analyzed using SPSS 20 (IBM, Armonk, NY, USA). We calculated SRs for each participant and the mean RT of all successfully completed trials for each participant, separately for the placebo and nocebo conditions. We only included the test blocks of the oxytocin and the “ineffective substance” blocks in our calculations. We then performed an ANOVA with the within-subjects factors expectancy (placebo vs. nocebo) and difficulty (easy vs. medium vs. hard) for the RT and SR data and performed paired $t$-tests as follow-up analyses.

Results

The results of this experiment precisely mirror the results of Follow-up Experiment I. Again, no expectancy effect emerged in either objective measure (SR: $F<1$; RT: $F<1$; Fig. B), but difficulty levels strongly affected SRs and RTs, as expected (SR: $F(2,54)=68.71$, $p<.001$, $\eta_p^2=0.72$; RT: $F(2,54)=171.99$, $p<.001$, $\eta_p^2=0.86$, $\varepsilon=.709$, Greenhouse-Geisser corrected for violations of sphericity; Fig. B).

![Fig. B](image)

**Fig. B.** (A) SRs and (B) RTs for placebo and control conditions in the arithmetic task of Follow-up Experiment II. No effects of expectancy emerged. Error bars indicate standard errors of the paired differences [33]. The expectancy instruction did not have any significant effects on SRs
or RTs, whereas the difficulty level had strong effects on both measures. No interaction of expectancy and difficulty emerged in either SRs or RTs.

SRs and RTs were significantly different between all difficulty levels, as follow-up paired t-tests indicated (all $p$s<.001). The expectancy x difficulty interaction did not approach significance for either measure (SR: $F<1$; RT: $F<1$). These results again indicate that the expectancy manipulation had no effect on any objective measure (Fig. B).

**Conclusion**

Our follow-up experiments were designed to investigate whether expectancy effects in objective measures in placebo or nocebo conditions did not emerge in our main experiment, because of our task choice or because of the applied expectancy manipulation. Therefore, we employed an arithmetic task that heavily relies on working memory capacity and that was already shown to be sensitive to instructions in research on stereotype threat. We also chose two different forms of expectancy manipulations to ensure that this factor was not crucial for our results. Both follow-up experiments showed very similar patterns: whereas difficulty levels had strong effects on success rates and reaction times, expectancy manipulations did not affect cognitive performance in any objective measure. This indicates that the results of our main experiment are valid in that objective measures targeting cognitive performance seem to remain unaffected by placebo or nocebo instructions; subjective measures, in contrast, were easily manipulated in our main experiment.

An additional observation concerns the reception of placebo instructions in the three different experiments: placebo instructions focusing on “frequency effects” as in the main experiment or on a plausible story without any sham intervention (Follow-up Experiment I) seemed to be more believable to the participants than the cover story allegedly involving an actual drug (Follow-up Experiment II). This seems counterintuitive given that the predominant view is that the more invasive the procedure the more effective the placebo instruction (e.g., [SR1]). However, during Follow-up Experiment II, some participants seemed more skeptical about the precise instructions (especially about when they were given which medication) and suspected deception. This skepticism seemed to be focused on the labelling of medication as “inactive” or “effective” which would explain why it primarily occurred in Follow-up Experiment II. Interestingly, this problem seems to be far more pronounced in the context of cognitive performance, whereas it is negligible in the context of placebo analgesia in our experience.
Supplementary References

SR1. Diener HC (2010). Placebo effects in treating migraine and other headaches. Curr Opin Investig Drugs 11(7): 735-739.
Data

Tab. S1. Reaction times (RTs) for each participant and condition in the test phase of the main experiment.

| Subject | Placebo Compatible | Placebo Incompatible | Nocebo Compatible | Nocebo Incompatible | Control Compatible | Control Incompatible |
|---------|--------------------|----------------------|-------------------|---------------------|--------------------|----------------------|
| 1       | 359                | 391                  | 352               | 394                 | 361                | 388                  |
| 2       | 387                | 454                  | 363               | 453                 | 371                | 458                  |
| 3       | 391                | 478                  | 398               | 475                 | 377                | 470                  |
| 4       | 365                | 435                  | 362               | 427                 | 357                | 431                  |
| 5       | 359                | 475                  | 379               | 460                 | 378                | 427                  |
| 6       | 352                | 379                  | 317               | 346                 | 326                | 323                  |
| 7       | 372                | 426                  | 365               | 440                 | 367                | 433                  |
| 8       | 324                | 381                  | 315               | 356                 | 310                | 374                  |
| 9       | 387                | 467                  | 386               | 522                 | 374                | 460                  |
| 10      | 399                | 476                  | 411               | 499                 | 406                | 466                  |
| 11      | 390                | 450                  | 372               | 446                 | 374                | 466                  |
| 12      | 351                | 395                  | 355               | 383                 | 362                | 419                  |
| 13      | 338                | 395                  | 353               | 403                 | 344                | 400                  |
| 14      | 337                | 380                  | 320               | 361                 | 319                | 360                  |
| 15      | 379                | 469                  | 364               | 462                 | 368                | 489                  |
| 16      | 363                | 452                  | 375               | 461                 | 357                | 447                  |
| 17      | 355                | 459                  | 363               | 460                 | 373                | 430                  |
| 18      | 340                | 387                  | 337               | 399                 | 340                | 393                  |
| 19      | 386                | 436                  | 368               | 421                 | 381                | 440                  |
| 20      | 344                | 438                  | 346               | 426                 | 339                | 451                  |
| 21      | 381                | 435                  | 375               | 442                 | 376                | 436                  |
| 22      | 368                | 458                  | 373               | 448                 | 374                | 462                  |
| 23      | 318                | 379                  | 307               | 337                 | 319                | 359                  |
| 24      | 358                | 447                  | 365               | 449                 | 353                | 454                  |
| 25      | 406                | 506                  | 399               | 498                 | 418                | 508                  |
| 26      | 399                | 441                  | 392               | 467                 | 393                | 460                  |
| 27      | 333                | 348                  | 317               | 332                 | 330                | 337                  |
| 28      | 433                | 532                  | 424               | 537                 | 428                | 524                  |
| 29      | 350                | 424                  | 341               | 409                 | 354                | 428                  |
| 30      | 361                | 445                  | 368               | 437                 | 364                | 425                  |
| 31      | 344                | 376                  | 342               | 384                 | 346                | 380                  |
| 32      | 363                | 429                  | 361               | 414                 | 367                | 454                  |
| 33      | 363                | 433                  | 360               | 422                 | 355                | 418                  |
| 34      | 351                | 401                  | 350               | 409                 | 351                | 424                  |
| 35      | 377                | 396                  | 333               | 391                 | 347                | 409                  |
| 36      | 323                | 387                  | 327               | 376                 | 333                | 382                  |
**Tab. S2.** Success rates (SRs) for each participant and condition in the test phase of the main experiment.

| Subject | Placebo Compatible | Placebo Incompatible | Nocebo Compatible | Nocebo Incompatible | Control Compatible | Control Incompatible |
|---------|-------------------|----------------------|------------------|---------------------|--------------------|----------------------|
| 1       | 0.66              | 0.26                 | 0.68             | 0.19                | 0.67               | 0.26                 |
| 2       | 0.94              | 0.30                 | 1.00             | 0.13                | 0.94               | 0.18                 |
| 3       | 0.97              | 0.25                 | 0.90             | 0.16                | 1.00               | 0.30                 |
| 4       | 0.84              | 0.13                 | 0.89             | 0.13                | 0.90               | 0.10                 |
| 5       | 1.00              | 0.33                 | 0.97             | 0.35                | 0.97               | 0.43                 |
| 6       | 0.68              | 0.12                 | 0.62             | 0.18                | 0.59               | 0.39                 |
| 7       | 1.00              | 0.54                 | 1.00             | 0.41                | 0.97               | 0.37                 |
| 8       | 0.94              | 0.25                 | 0.97             | 0.34                | 0.92               | 0.21                 |
| 9       | 0.78              | 0.05                 | 0.71             | 0.00                | 0.80               | 0.11                 |
| 10      | 0.92              | 0.15                 | 0.92             | 0.06                | 0.80               | 0.17                 |
| 11      | 0.88              | 0.50                 | 0.97             | 0.50                | 1.00               | 0.46                 |
| 12      | 0.92              | 0.21                 | 0.80             | 0.33                | 0.82               | 0.13                 |
| 13      | 0.92              | 0.44                 | 0.83             | 0.30                | 0.94               | 0.29                 |
| 14      | 0.89              | 0.29                 | 0.97             | 0.45                | 0.89               | 0.36                 |
| 15      | 0.91              | 0.11                 | 1.00             | 0.17                | 0.98               | 0.15                 |
| 16      | 1.00              | 0.31                 | 0.97             | 0.28                | 1.00               | 0.27                 |
| 17      | 0.97              | 0.17                 | 0.85             | 0.06                | 0.81               | 0.33                 |
| 18      | 0.91              | 0.28                 | 0.96             | 0.27                | 0.95               | 0.30                 |
| 19      | 0.94              | 0.29                 | 0.94             | 0.53                | 0.97               | 0.37                 |
| 20      | 1.00              | 0.06                 | 1.00             | 0.15                | 0.97               | 0.06                 |
| 21      | 0.95              | 0.25                 | 0.92             | 0.13                | 0.79               | 0.24                 |
| 22      | 0.98              | 0.17                 | 1.00             | 0.15                | 0.97               | 0.06                 |
| 23      | 0.97              | 0.31                 | 1.00             | 0.32                | 0.95               | 0.36                 |
| 24      | 0.91              | 0.22                 | 0.97             | 0.24                | 0.93               | 0.24                 |
| 25      | 0.90              | 0.21                 | 0.90             | 0.18                | 0.77               | 0.13                 |
| 26      | 0.74              | 0.16                 | 0.83             | 0.10                | 0.72               | 0.12                 |
| 27      | 0.73              | 0.24                 | 0.79             | 0.31                | 0.78               | 0.27                 |
| 28      | 0.92              | 0.26                 | 1.00             | 0.31                | 0.91               | 0.31                 |
| 29      | 1.00              | 0.66                 | 0.97             | 0.61                | 1.00               | 0.42                 |
| 30      | 0.95              | 0.03                 | 0.84             | 0.15                | 0.95               | 0.30                 |
| 31      | 0.81              | 0.45                 | 0.89             | 0.43                | 0.82               | 0.50                 |
| 32      | 1.00              | 0.11                 | 0.97             | 0.25                | 1.00               | 0.17                 |
| 33      | 1.00              | 0.37                 | 1.00             | 0.47                | 1.00               | 0.33                 |
| 34      | 0.83              | 0.18                 | 0.86             | 0.19                | 0.76               | 0.10                 |
| 35      | 0.74              | 0.28                 | 0.88             | 0.30                | 0.94               | 0.23                 |
| 36      | 0.97              | 0.16                 | 0.94             | 0.06                | 0.94               | 0.09                 |
**Tab. S3.** Ratings for each participant and condition of the main experiment.

| Subject | Placebo | Nocebo | Control |
|---------|---------|--------|---------|
| 1       | 8       | 3      | 4       |
| 2       | 6       | 6      | 6       |
| 3       | 7       | 5      | 6       |
| 4       | 6       | 7      | 3       |
| 5       | 6       | 4      | 6       |
| 6       | 8       | 1      | 6       |
| 7       | 5       | 5      | 3       |
| 8       | 6       | 3      | 4       |
| 9       | 6       | 3      | 6       |
| 10      | 1       | 1      | 8       |
| 11      | 8       | 3      | 6       |
| 12      | 7       | 2      | 3       |
| 13      | 4       | 3      | 6       |
| 14      | 8       | 4      | 1       |
| 15      | 6       | 5      | 3       |
| 16      | 3       | 3      | 6       |
| 17      | 7       | 4      | 6       |
| 18      | 6       | 4      | 5       |
| 19      | 7       | 7      | 3       |
| 20      | 4       | 2      | 6       |
| 21      | 5       | 1      | 7       |
| 22      | 3       | 4      | 3       |
| 23      | 7       | 5      | 5       |
| 24      | 6       | 7      | 4       |
| 25      | 5       | 7      | 2       |
| 26      | 5       | 4      | 3       |
| 27      | 5       | 2      | 5       |
| 28      | 6       | 5      | 2       |
| 29      | 8       | 3      | 3       |
| 30      | 5       | 5      | 5       |
| 31      | 5       | 2      | 1       |
| 32      | 7       | 4      | 5       |
| 33      | 8       | 4      | 7       |
| 34      | 8       | 3      | 4       |
| 35      | 6       | 3      | 5       |
| 36      | 7       | 5      | 5       |
Tab. S4. Reaction times (RTs) for each participant and condition in Follow-up Experiment I.

| Subject | Placebo |       |       |       | Nocebo |       |       |
|---------|---------|-------|-------|-------|--------|-------|-------|
|         | easy    | medium| hard  | easy  | medium | hard  |       |
| 1       | 1866    | 6887  | 9053  | 2750  | 4208   | 12369 |       |
| 2       | 1798    | 3422  | 6640  | 1705  | 2717   | 6081  |       |
| 3       | 2439    | 4201  | 6581  | 1686  | 3743   | 4799  |       |
| 4       | 1716    | 3465  | 6000  | 1822  | 3654   | 6231  |       |
| 5       | 1571    | 4468  | 6499  | 2064  | 6449   | 8011  |       |
| 6       | 1880    | 3607  | 5595  | 1760  | 4081   | 4924  |       |
| 7       | 2019    | 4549  | 4549  | 1908  | 3244   | 4430  |       |
| 8       | 1581    | 2611  | 3483  | 1613  | 2854   | 2850  |       |
| 9       | 2275    | 3746  | 6041  | 2463  | 4116   | 5087  |       |
| 10      | 1618    | 2426  | 5430  | 2134  | 3450   | 6407  |       |
| 11      | 1496    | 2320  | 4125  | 1728  | 2927   | 4077  |       |
| 12      | 2597    | 4386  | 5456  | 1916  | 3372   | 6894  |       |
| 13      | 1349    | 3430  | 4009  | 1676  | 2979   | 4258  |       |
| 14      | 1314    | 2259  | 3321  | 1252  | 2065   | 3832  |       |
| 15      | 2033    | 5964  | 7722  | 1641  | 4026   | 6266  |       |
| 16      | 1412    | 2961  | 4467  | 1361  | 2354   | 3834  |       |
| 17      | 2953    | 10184 | 13929 | 3769  | 8873   | 10606 |       |
| 18      | 1760    | 2762  | 4047  | 1537  | 2974   | 4435  |       |
| 19      | 3016    | 4431  | 6202  | 5363  | 10037  | 9311  |       |
| 20      | 2060    | 4584  | 6630  | 2010  | 3378   | 5445  |       |
| 21      | 2186    | 3082  | 5218  | 2056  | 4565   | 5286  |       |
| 22      | 2535    | 4430  | 5829  | 2129  | 4418   | 6135  |       |
| 23      | 1765    | 3829  | 6383  | 2057  | 5286   | 6546  |       |
| 24      | 1476    | 3323  | 6440  | 1140  | 2522   | 3615  |       |
| 25      | 2835    | 5711  | 11955 | 4460  | 8655   | 11659 |       |
| 26      | 1974    | 5126  | 10094 | 2291  | 6348   | 9293  |       |
| 27      | 2352    | 7510  | 10766 | 2231  | 5292   | 10115 |       |
| 28      | 1615    | 3610  | 5114  | 1531  | 3098   | 4252  |       |
| 29      | 2781    | 4768  | 7783  | 2613  | 5298   | 9218  |       |
| 30      | 3443    | 9817  | 14714 | 2572  | 6647   | 11208 |       |
| 31      | 1701    | 2869  | 6531  | 1797  | 2896   | 4613  |       |
| 32      | 2300    | 4471  | 4339  | 2464  | 4669   | 7071  |       |
| 33      | 1838    | 2333  | 3670  | 1885  | 3928   | 4190  |       |
| 34      | 1963    | 4102  | 8967  | 1936  | 4380   | 6568  |       |
| 35      | 1697    | 3049  | 4098  | 1329  | 2194   | 3972  |       |
| 36      | 3772    | 6549  | 7528  | 3839  | 8713   | 10399 |       |
| 37      | 3641    | 4613  | 5453  | 2779  | 4240   | 6396  |       |
| 38      | 1499    | 3390  | 5940  | 2098  | 3585   | 6874  |       |
Tab. S5. Success rates (SRs) for each participant and condition in Follow-up Experiment I.

| Subject | Placebo |       |       |       | Nocebo |       |       |       |
|---------|---------|-------|-------|-------|--------|-------|-------|-------|
|         | easy    | medium| hard  | easy  | medium | hard  |       |       |
| 1       | 0.94    | 0.89  | 0.83  | 0.94  | 0.89   | 0.72  |       |       |
| 2       | 1.00    | 0.83  | 1.00  | 0.94  | 0.94   | 0.83  |       |       |
| 3       | 1.00    | 0.83  | 0.72  | 0.89  | 0.83   | 0.78  |       |       |
| 4       | 0.94    | 0.94  | 0.89  | 0.94  | 0.94   | 1.00  |       |       |
| 5       | 0.94    | 1.00  | 1.00  | 0.94  | 0.78   | 0.94  |       |       |
| 6       | 1.00    | 1.00  | 0.83  | 1.00  | 1.00   | 0.89  |       |       |
| 7       | 0.89    | 0.94  | 0.83  | 0.94  | 0.89   | 0.89  |       |       |
| 8       | 1.00    | 0.67  | 0.61  | 0.83  | 0.78   | 0.61  |       |       |
| 9       | 0.89    | 0.83  | 0.67  | 0.94  | 0.83   | 0.78  |       |       |
| 10      | 0.94    | 0.83  | 0.78  | 1.00  | 0.89   | 0.78  |       |       |
| 11      | 1.00    | 1.00  | 0.89  | 0.94  | 0.89   | 0.89  |       |       |
| 12      | 0.89    | 0.94  | 0.78  | 1.00  | 0.94   | 0.89  |       |       |
| 13      | 0.94    | 0.94  | 0.89  | 0.94  | 0.94   | 0.89  |       |       |
| 14      | 0.94    | 1.00  | 0.94  | 0.94  | 1.00   | 0.89  |       |       |
| 15      | 0.94    | 0.94  | 0.94  | 1.00  | 1.00   | 0.89  |       |       |
| 16      | 0.94    | 0.94  | 0.89  | 1.00  | 0.83   | 0.89  |       |       |
| 17      | 1.00    | 1.00  | 0.89  | 1.00  | 0.89   | 0.78  |       |       |
| 18      | 1.00    | 0.94  | 0.78  | 0.94  | 1.00   | 0.83  |       |       |
| 19      | 1.00    | 0.94  | 0.61  | 0.83  | 0.56   | 0.44  |       |       |
| 20      | 1.00    | 0.89  | 0.83  | 1.00  | 0.89   | 0.89  |       |       |
| 21      | 0.94    | 0.78  | 0.89  | 1.00  | 0.72   | 0.83  |       |       |
| 22      | 0.94    | 0.78  | 0.72  | 0.94  | 0.67   | 0.50  |       |       |
| 23      | 0.94    | 0.94  | 0.83  | 1.00  | 0.94   | 0.78  |       |       |
| 24      | 1.00    | 1.00  | 0.89  | 0.89  | 0.89   | 0.78  |       |       |
| 25      | 0.94    | 0.72  | 0.67  | 0.94  | 0.72   | 0.94  |       |       |
| 26      | 1.00    | 1.00  | 1.00  | 1.00  | 1.00   | 0.94  |       |       |
| 27      | 1.00    | 0.89  | 0.94  | 1.00  | 0.89   | 0.78  |       |       |
| 28      | 0.94    | 0.94  | 0.83  | 1.00  | 1.00   | 0.78  |       |       |
| 29      | 1.00    | 1.00  | 0.94  | 1.00  | 1.00   | 0.94  |       |       |
| 30      | 0.89    | 0.83  | 0.89  | 0.94  | 0.94   | 0.78  |       |       |
| 31      | 0.94    | 0.94  | 0.89  | 1.00  | 0.89   | 0.83  |       |       |
| 32      | 0.83    | 0.83  | 0.78  | 1.00  | 0.67   | 0.67  |       |       |
| 33      | 1.00    | 0.94  | 0.89  | 0.94  | 1.00   | 1.00  |       |       |
| 34      | 0.78    | 1.00  | 0.89  | 0.94  | 0.83   | 0.94  |       |       |
| 35      | 1.00    | 0.89  | 0.89  | 0.94  | 0.78   | 0.83  |       |       |
| 36      | 0.94    | 0.67  | 0.67  | 0.89  | 0.61   | 0.56  |       |       |
| 37      | 0.83    | 0.72  | 0.78  | 0.94  | 0.83   | 0.78  |       |       |
| 38      | 1.00    | 0.89  | 0.72  | 1.00  | 0.78   | 0.78  |       |       |
Tab. S6. Reaction times (RTs) for each participant and condition in Follow-up Experiment II.

| Subject | Placebo easy | Placebo medium | Placebo hard | Control easy | Control medium | Control hard |
|---------|--------------|----------------|--------------|--------------|----------------|--------------|
| 1       | 2713         | 3462           | 4311         | 2821         | 4338           | 4156         |
| 2       | 1999         | 3500           | 4840         | 2574         | 4373           | 5403         |
| 3       | 2762         | 4053           | 5515         | 3757         | 4663           | 5227         |
| 4       | 2791         | 3872           | 4422         | 2694         | 4362           | 4960         |
| 5       | 2940         | 4463           | 5251         | 3611         | 5014           | 4999         |
| 6       | 2374         | 3428           | 4105         | 2539         | 3893           | 3886         |
| 7       | 2921         | 4457           | 4227         | 2947         | 4427           | 4915         |
| 8       | 3026         | 3607           | 4623         | 2391         | 3838           | 4876         |
| 9       | 2968         | 4824           | 5512         | 2772         | 4396           | 5381         |
| 10      | 3496         | 4785           | 5265         | 3364         | 4675           | 5075         |
| 11      | 4439         | 4202           | 3949         | 4681         | 4573           | 4525         |
| 12      | 3002         | 4751           | 5309         | 2784         | 3290           | 5304         |
| 13      | 2928         | 4135           | 4967         | 3365         | 5197           | 5136         |
| 14      | 3458         | 4587           | 6314         | 3083         | 4069           | 5142         |
| 15      | 2678         | 5112           | 5612         | 3421         | 5384           | 5755         |
| 16      | 3076         | 3822           | 4283         | 2792         | 3939           | 4621         |
| 17      | 3299         | 4698           | 4826         | 4426         | 5111           | 4519         |
| 18      | 3461         | 4093           | 5104         | 3233         | 4406           | 4549         |
| 19      | 2428         | 4747           | 5436         | 2870         | 4466           | 4906         |
| 20      | 4041         | 5373           | 4512         | 3892         | 4992           | 5372         |
| 21      | 3307         | 4935           | 4661         | 3043         | 4259           | 5867         |
| 22      | 4030         | 5605           | 6243         | 3475         | 4582           | 3895         |
| 23      | 3082         | 4822           | 5694         | 3368         | 4736           | 5240         |
| 24      | 2779         | 4515           | 5350         | 3348         | 5174           | 5598         |
| 25      | 4457         | 4687           | 5575         | 3290         | 4615           | 4636         |
| 26      | 3043         | 4911           | 5124         | 3762         | 4867           | 5356         |
| 27      | 2605         | 3694           | 5333         | 2371         | 4544           | 5775         |
| 28      | 2763         | 4056           | 4716         | 3303         | 3893           | 5073         |
Tab. S7. Success rates (SRs) for each participant and condition in Follow-up Experiment II.

| Subject | Placebo |       |       | Control |       |       |
|---------|---------|-------|-------|---------|-------|-------|
|         | easy    | medium| hard  | easy    | medium| hard  |
| 1       | 0.75    | 0.81  | 0.56  | 0.75    | 0.94  | 0.63  |
| 2       | 1.00    | 1.00  | 0.75  | 1.00    | 0.94  | 0.56  |
| 3       | 0.88    | 0.63  | 0.50  | 0.69    | 0.44  | 0.38  |
| 4       | 0.94    | 0.88  | 0.56  | 0.69    | 0.94  | 0.56  |
| 5       | 0.88    | 0.63  | 0.44  | 1.00    | 0.75  | 0.44  |
| 6       | 1.00    | 0.88  | 0.81  | 1.00    | 0.81  | 0.69  |
| 7       | 1.00    | 0.88  | 0.50  | 0.88    | 0.63  | 0.69  |
| 8       | 1.00    | 0.88  | 0.69  | 0.94    | 0.69  | 0.38  |
| 9       | 0.94    | 0.63  | 0.56  | 0.94    | 0.63  | 0.50  |
| 10      | 0.69    | 0.50  | 0.50  | 0.88    | 0.63  | 0.56  |
| 11      | 0.63    | 0.56  | 0.38  | 0.56    | 0.63  | 0.63  |
| 12      | 1.00    | 0.88  | 0.69  | 1.00    | 0.81  | 0.88  |
| 13      | 0.69    | 0.69  | 0.50  | 0.88    | 0.56  | 0.56  |
| 14      | 0.88    | 0.75  | 0.13  | 1.00    | 0.88  | 0.63  |
| 15      | 0.88    | 0.50  | 0.56  | 0.88    | 0.44  | 0.38  |
| 16      | 1.00    | 0.81  | 0.63  | 1.00    | 0.94  | 0.75  |
| 17      | 0.88    | 0.75  | 0.75  | 0.56    | 0.75  | 0.50  |
| 18      | 0.69    | 0.56  | 0.69  | 0.69    | 0.44  | 0.63  |
| 19      | 0.94    | 0.94  | 0.75  | 1.00    | 0.81  | 0.63  |
| 20      | 0.81    | 0.50  | 0.38  | 0.81    | 0.56  | 0.44  |
| 21      | 0.94    | 0.75  | 0.81  | 0.94    | 0.69  | 0.69  |
| 22      | 0.81    | 0.38  | 0.25  | 1.00    | 0.56  | 0.19  |
| 23      | 0.75    | 0.44  | 0.44  | 0.69    | 0.63  | 0.56  |
| 24      | 0.75    | 0.69  | 0.81  | 0.69    | 0.69  | 0.44  |
| 25      | 0.81    | 0.44  | 0.56  | 0.81    | 0.69  | 0.31  |
| 26      | 0.88    | 0.44  | 0.50  | 0.81    | 0.69  | 0.63  |
| 27      | 0.94    | 0.81  | 0.50  | 1.00    | 0.94  | 0.50  |
| 28      | 0.88    | 0.75  | 0.38  | 1.00    | 0.63  | 0.56  |