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Pain Relief and Relaxation Through Listening to EEG- Based Auditory Patterns

A Long-Term Study on Psychofonie

Authors:

Bruno Fricker
Dipl. Physiker ETH
Swiss Forum of Psychofonie
Brunnenmoosstrasse 7
CH-8802 Kilchberg ZH
Switzerland

Burkhardt Seifert
Prof. Dr. rer. nat.
Biostatistics Unit ISPM
University of Zurich
Hirschengraben 84
CH-8001 Zürich
Switzerland

Correspondence address:

Bruno Fricker
Swiss Forum of Psychofonie
Brunnenmoosstrasse 7
CH-8802 Kilchberg ZH
Switzerland

bruno.fricker@spectralab.ch

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Abstract

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▪ *Introduction.* The off-line neurofeedback method termed Psychofonie® has been widely applied in Switzerland for 15 years. To get a picture of the benefits, a long-term study was conducted of 163 patients of all ages, randomly selected and predominantly women. By means of a questionnaire, they retrospectively recorded participant usage of the audio-cerebral method of self-regulation therapy and its effects on a series of outcomes. The same sound pattern derived from a patient's single EEG could be used for months or even years.
- *Method.* Data were collected representing patient use of Psychofonie for as little as a few months or as many as ten years. Patients quantified the duration of self-treatment and reported changes in their overall condition, physical complaints, mental state and social behavior, and in more specific effectiveness aspects.
- *Results.* After an initial training period of three months, significant improvements were found. These improvements were greater with longer Psychofonie use and were sustained even after usage had ended. Some outcomes were specifically investigated. The therapy was most effective in helping achieve relaxation, followed then in order by sleep improvement, relief of migraines and simple headaches, ability to work, and ability to concentrate. Sensitivity to tinnitus was reduced in some cases as well.
- *Conclusion.* These findings corresponded well with earlier studies, in which six out of ten subjects experienced significant improvement in similar effects. The study results suggest that the same sound pattern derived once from a subject's EEG could be sustained in use for months or years.

1 Introduction

The auditory intervention technique *Psychofonie* has been used by medical professionals in Switzerland, Germany, and Austria to treat thousands of patients in the last 15 years. The new therapy was initially recommended only as a solution of last resort. Nevertheless, it has brought about improvements in the majority of cases with lasting relief for several functional disorders. Early studies previously documented the effectiveness of Psychofonie. The open pilot study [1] on 128 cases reported a reduction in frequency and intensity in migraines and a reduction in the intake of pharmaceuticals after four weeks. Because of promising results, further investigations were recommended to evaluate the long-term effect of Psychofonie since the response from placebos only lasts for short periods. Thereafter, a Swiss hospital studied the efficacy of Psychofonie on migraines for one year in 46 cases.[2] They measured a pronounced effect after patients listened to the sound pattern three times each day for three months. Based on a professional survey, patients experienced even more relief after 6, 9, and 12 months of application, and they reduced the consumption of pain medications accordingly. Three migraine centers in Salzburg, Erlangen, and Berlin contributed to a third study that included a control group in a randomized double-blind setting published in 2002 in [3]. The study compared Psychofonies derived from individual electroencephalograms (EEGs) against placebo Psychofonies derived from averaged third-party EEGs without any individual content. Despite indistinguishable sound patterns, the effect was significantly better in the treatment group. Since this study was conducted during a 12-week treatment period only and since [2] there was evidence for much better results after one year, we carried out the present pilot survey that summarized the long-term experience of many patients. We sent out a simple one-page self-explanatory questionnaire[9] to a randomized address base of the Swiss clientele asking them to answer immediately, truthfully, and without medical professional assistance or bias that would prevent objective consideration. This is the weakness and strength of this study. Each patient filled in the questionnaire uninfluenced and only once. In this way, the reports documented patients who were at different points in the course of and aftermath of the treatment. Together a picture emerged of how the patients thought that Psychofonie affected various pain and suffering, after

1 treatment periods of 1 to 144 months, although there is no means and no need to
2 distinguish between self-healing and specific effects that may be too limited to
3 explain a complex regulation therapy such as Psychofonie.
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9 **2 What is Psychofonie?**

10 To produce the individualized Psychofonie Audio CD, a 17-minute-long, four-channel
11 resting state EEG is recorded during a patient's pain-free period. Artifacts are visually
12 removed in this one-time collected data in a central laboratory, and after a frequency-
13 analytical procedure, it is transformed into a four-channel audio sequence. Based on
14 the rhythm and frequency fluctuations of the brain waves (excluding the alpha
15 waves), musical notes are computed and copied to audio CD in the form of a midi
16 sound sequence. The patient listens to the CD for 12 minutes, 3 times a day, for
17 several weeks. The rhythmic sounds serve as instrumental conditioning in an open
18 neurofeedback loop involving an area in the midbrain that is interconnected with the
19 central auditory pathway.[4] EEG rhythms are partially induced via thalamo-cortical
20 loops from the vegetative and pain-modulating brain nuclei.[5] These waves are then
21 FFT-filtered through the Psychofonie method and transformed into hard-to-remember
22 and inharmonious sequences of sound and rhythm. Efficiency builds slowly but
23 strongly as patients continue their therapy over several weeks.[6]
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41 **3 Motivation and Background**

42 The collective experiences with Psychofonie ascertained by 24 Swiss clinics over the
43 course of ten years were the motivation for this study. The Psychofonie method
44 became increasingly known. Physicians who included Psychofonie in their therapy
45 plans reported relatively high compliance in long-term use among patients who had
46 Psychofonie CDs generated from their EEGs. A second EEG recording was needed
47 only in rare cases in which the effect could not be refreshed using the original
48 recording. Current research had previously focused only on short time spans. The
49 goal of this study is to follow many patients, both those who have completed
50 treatment and those that are currently undergoing the Psychofonie method at the
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time of this study. In this way, data involving patients that have experience with Psychofonie for as little as one month or as long as ten years can be collected and analyzed.

Psychofonie is a standardized method, as clinics and physicians in private practice were responsible only for the recording of the EEGs. All audio material was edited by a single laboratory in Switzerland using the same method each time.[7] Thus, the long-term data are readily comparable.

Psychofonie encompasses aspects of several known therapy models, such as music therapy, neurofeedback, and hypnosis.[8] This study is designed to elaborate on Psychofonie's effectiveness, as defined below. Patient self-report in various criteria of pain, complaints, and duration of relief provided data for in-depth analysis of Psychofonie.

The following questions were posed and tested:

- a) Did the Psychofonie method result in a significant decrease in patient complaints over the course of the self-treatment?
- b) Was the expectation of sustained, or even increased, improvement after the end of the treatment fulfilled?
- c) How long were the Psychofonie treatments?
- d) How did patient rankings in the various specific criteria described in section 4.2 change during the observation periods?
- e) Were there any correlations between criteria?
- f) Was the efficiency of the Psychofonie method significantly affected when paired with concurrent medicinal treatment? Did a considerable number of Psychofonie listeners succeed in reducing their medication dosage?

4 Method

All data in this study were obtained through the use of a voluntary and anonymous *questionnaire*.^[9] It was sent by surface mail one time only and concurrently to a random sample of patients of Psychofonie treatment without any preferences.

4.1 Questions of Personal Nature

Information concerning year of birth, gender, start date of therapy (month and year), frequency of Psychofonie use, and end date of therapy were collected. Out of 163 respondents, three quarters were female. Most participants were Swiss German. Age distribution, among those reporting their age, ranged between 7 and 75 years, and is depicted in figure 1. The questionnaire requested personal motives and judgments from the participants where they could clarify important experiences or provide background information, but, in particular, this background information is beyond the scope of this study. Further inquiries or clarifications beyond the questionnaire results were not pursued.

4.2 Questions Regarding Effectiveness

Overall condition, physical health, mental condition, social contacts, and prescription medications were assessed at the beginning of therapy, the end of therapy (if applicable), and at the time of the questionnaire. These data were collected on a scale with 5 stages ranging from very bad to very good. Participant responses were independent of influence by medical personnel, assuring legitimate and reliable personal responses, since, in many cases, patient rankings took place after therapy was completed.

Desirable outcomes for which Psychofonie is typically indicated were identified for measurement in the study. These outcomes include pain reduction, diminished tinnitus, decreased prescription medication, and an improvement in sleep, relaxation, attentiveness, and work performance.

5 Results

5.1 *The Evolution of Effectiveness Over Time*

The general evolution of the effectiveness was computed as the sum of the differences in all criteria from section 4.2 before and after treatment (improvement score). Improvement scores and treatment duration were computed from the questionnaire data of 108 patients, though, in 40 cases, treatment dates were missing so only improvement scores were calculated in those cases. Improvement scores and treatment duration, divided into time sections, are depicted as box plots in figure 2. As seen in this figure, the typical patient began to see improvement after about four months of Psychofonie treatment. Thereafter, the effect continued, and even increased, in the group of long-term listeners (with 4 to 10 years of treatment). In the rare event that subjects did not experience desirable outcomes, a negative score was calculated. According to the Mann-Whitney Test (statistically significant for $p < 0.05$), improvement between the groups from 1 to 3 and 4 to 122 months is with $p = 0.002$ statistically highly significant.

In cases in which treatment had already ended at the time of this survey, the data not only included the period of treatment but also the period of time since Psychofonie therapy had ended. On average, the time span that had passed since therapy had ended was about 3 years (35 ± 30 months), and therapy duration had continued for about 2 years (24 ± 24 months). The hypothesis was that the long-term benefits of Psychofonie, after ending treatment, would not diminish. Figure 3 demonstrates that, in all four symptom criteria, there is lasting improvement even years after treatment has ended. According to the Wilcoxon Signed-Rank Test (statistically significant for $p < 0.025$ with Bonferroni-Correction), improvements throughout the treatment and after the treatment are significant, except one bar # ($p = 0.038$).

5.2 *Patient Improvement*

Using the improvement score data, patient improvement was analyzed (figure 4). Four out of 108 subjects (4%) experienced a minor worsening of symptoms during Psychofonie treatment. Seven patients (6%) experienced no change. Ninety-seven

participants (90%) reported symptom improvement after the treatment, 55 (51%) of those with remarkable improvement scores of ten or more.

5.3 The Specific Effectiveness

Figure 5 provides an overview of the distribution of the seven desirable outcomes mentioned above. The number of participants who made statements concerning the improvement in each outcome criterion was counted.

Figure 6 illustrates, based on the sum of improvement scores in each criterion, the ranking of the effect that Psychofonie and spontaneous recovery had on the seven specific criteria. Of course, the two factors cannot be separated in this study.

5.3.1 Correlation Between the Use of Medication and Pain Reduction

The use of analgesics is a common but controversial practice in the treatment of headaches. Frequent use of pain killers against tension-type headache may lead to the development of medication-overuse headaches. But, in patients involved in the study, 46 could reduce the use of medicine to treat episodic headaches and migraines, and 34 were able to decrease reliance on medication intended for long-term use. Decreased reliance on medication was, by far, the most often mentioned reason for Psychofonie treatment. This was experienced by 48 patients.

As was to be expected, there was a strong correlation between medication reduction and pain relief, as depicted in figure 7. Each point corresponds to one of the 52 patients who stated that they had experienced improvements in the two criteria. Kendall's Tau is a rank correlation coefficient especially designed for ordinal data and hence appropriate in this situation. Kendall's Tau beta gives a correlation coefficient of 0.47, with $p=0.0001$ the paired effects are highly correlated.

5.3.2 Correlation Between Attentiveness and Work Performance

Fifty-five participants reported an improvement in both attentiveness and work performance. The strong correlation is depicted in figure 8. The two axes (terms) are nearly interchangeable. With Kendall's Tau beta = 0.61 with $p<0.0001$ this is a highly

significant monotonous correspondence. Attentiveness and work performance are nearly interchangeable.

6 Discussion

6.1 Evolution of the Effectiveness

Long-term improvement is most vividly seen in the scatter plot in figure 9. This is a local polynomial ride regression plot according to Seifert B. in R package version 1.0-4, packaged for R by M. Maechler. Of the 108 participants, there was a significant increase in improvement of the group with only 1 to 3 months of Psychofonie therapy compared to the group with 4 to 122 months of treatment (figure 2). This finding corresponds with a previous study of Psychofonie [2] conducted at the public hospital in Glarus (Switzerland), in which a group of 46 migraine patients needed 3 months of treatment before experiencing significant improvement. In the following 9 months, the improvements continued to increase, which is untypical for placebo, and after one year, 56% of the patients showed an improvement of at least 50% of their migraine symptoms. Remarkably, most of the patients included in the Glarus study had suffered from migraines for years, despite the usual migraine therapies. Therefore the authors concluded that Psychofonie is effective in treating migraines. Data analysis provided in figure 2 shows not only the improvement over time, but also the fact that there is a clear benefit to all groups as a result of utilizing Psychofonie treatment, compared to participant status at the beginning of therapy (baseline). Only in a group with just 1 to 2 months of treatment was there no significant improvement in symptoms experienced. This result reflects comparable results obtained in a pilot survey, conducted in 1997, as seen in figure 10. In this survey, 135 similar questionnaires, representing data collected over a period of 18 months from an entirely different sample of patients, were analyzed. It is therefore recommended to undergo Psychofonie therapy for at least four months since *the maximum benefit isn't fully realized until four months after Psychofonie treatment begins.*

1 We did not use a well-investigated standardized questionnaire because none are
2 simple enough for self-scoring at home without professional guidance. Further, a
3 control group was beyond the scope of this long-term pilot survey, and it cannot be
4 excluded that the treatment effects are simply due to time and not to procedure. The
5 scope was to get a clear picture of how patients can indeed manage severe
6 complaints with the voluntary use of this, and only this, aid—Psychofonie—without
7 further professional assistance.
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13 Figure 4 shows that *two thirds of the 108 patients who completed the questionnaire*
14 *in full reported a pain reduction improvement score greater than or equal to 6 after*
15 *treatment with Psychofonie.* The 40 participants that did not report on time spans, as
16 shown in figure 2, saw less improvement than others. Questionnaire responses seem
17 to suggest that possibly some of the respondents were not diligent enough about
18 following recommended treatment guidelines. Figure 4 confirms the first inquiry into
19 the matter in which Trzopek, et. al.,[1] found that 82% of 128 migraine patients
20 experienced noticeable relief from illness after three months of treatment.
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28 Trinka, et. al., showed in a placebo-controlled, randomized, blind study based on
29 standardized questionnaires significant improvement in headaches and
30 accompanying gastrointestinal complaints when using Psychofonie in the
31 experimental group versus random sound patterns used by the control group of
32 migraine patients. The same paper also includes a detailed description of the
33 Psychofonie method of EEG-recording, frequency analysis, and the conversion into
34 pitch and duration values of musical notes in chromatic scale. We avoid the repetition
35 of those technical explanations because it is in [3].
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44 As seen in figure 4, eleven people were inconsistent with Psychofonie therapy. Some
45 of them didn't listen to Psychofonie long enough, while others continued to use high-
46 dose prescription medication, especially for general pain relief, migraines, or sleep
47 disturbances. It was difficult to discern Psychofonie's effectiveness when these
48 factors were also involved.
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6.2 Specific Aspects of Recovery

Through the use of Psychofonie, 119 patients noticed a very clear relaxation effect, often just days after beginning the treatment. Psychofonie worked very well in improving sleep disturbances and insomnia as well. Psychofonie therapy also resulted in the successful relief from pain when treating migraines and primary headaches, in which 112 patients showed improvements, half of whom experienced medium to complete relief of symptoms. Many of these patients were able to decrease their reliance on prescription pain medication. There was a significant correlation between the reduction in medication use and pain relief. Additionally, benefit was derived in the areas of attentiveness and work performance, the two criteria being virtually interchangeable. In the case of tinnitus, only a few patients reported a decrease in symptoms. However, ten patients experienced a total reversal of tinnitus.

6.3 Conclusion

Even more clearly than previous studies using shorter observation periods, this long-term study suggests that Psychofonie is a long-lasting and highly effective therapy for relaxation, relief from migraines and headaches, and for the regulation of associated vegetative disturbances. Remarkable patient compliance with Psychofonie ensures that they are likely to use their Psychofonie CD for years to come. Some medical professionals purport that Psychofonie is little more than a placebo. We present this study as a contribution to a deeper and more nuanced understanding and to stimulate further research. We let the results speak for themselves. Psychofonie can support the body's self-healing mechanisms. This is evidenced by the 33 patients that claimed that they felt like new people after having undergone Psychofonie therapy. Unlike the placebo, whose effectiveness quickly diminishes, Psychofonie has staying power. It is not a deception. It is what it claims to be: the careful musical transcription of each person's unique EEG.

7 Acknowledgement

We wish gratefully to acknowledge long-lasting professional collaboration with all Swiss Psychofonie-using doctors as recognized at <http://www.psychofonie.ch> and scientific consulting with the physicians Klaus Tereh (Bern), Eva Dinkel and Markus Fischer (Winterthur), Kaspar Rhyner (Glarus), Hansruedi Stäheli (Siegershausen) and the neurologists Roland Markoff (Chur) and H. G. Trzopek (Berlin).

Legends to Figures

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3 Figure 1 Age distribution
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6 Figure 2 Boxplot of the improvements, accumulated scores per patient versus grouped durations of
7 self-treatment. Each box shows from bottom to top the 25% quartiles, the median(—), the arithmetic
8 mean(◆), and the 75% quartiles. Above each box the number of patients is indicated, and underneath
9 the time span covered is indicated. It shows significantly better improvement of group (*) vs. the
10 group of 1 to 3 months ($p=0.002$). The scores of those respondents who did not supply the duration of
11 self-treatment (indicated by ?) were significantly lower ($p=0.019$) compared to those who did provide
12 this information. The scores after treatment compared to those before treatment improved significantly
13 in *all* groups.
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19 Figure 3 The columns show the average improvement and standard deviation throughout the
20 treatment and after the treatment (dark) overall as well as specifically physically, mentally, and
21 socially. Throughout treatment and after the end of therapy, the improvements are significant ($p<0.025$
22 after Bonferroni-Correction), except that marked with (#) ($p=0.038$).
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26 Figure 4 Breakdown of therapy successes and failures by groups above certain levels of improvement.
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29 Figure 5 Boxplot like in figure 2. Improvement scores in the seven specific outcomes, with one outlier
30 (□). In the upper border, the number of patients in the boxes underneath are listed.
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33 Figure 6 Ranking of the seven specific dimensions of recovery based on the summed scores.
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36 Figure 7 Pain relief against medication reduction showed a significant correlation. In this pair plot, a
37 randomly generated jitter was added to the usually coincident points, because of which ordinal values
38 are slightly separated, but visible.
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42 Figure 8 Pair plot of the two ordinal variables: work performance against attentiveness.
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45 Figure 9 Scatter plot depicting long-term improvements. The curve shows a local smoother of the type
46 *lpridge* of the average benefit over the durations of self-treatment.[10] The average improvement
47 increased constantly. The 108 points were slightly jittered so they don't coincide.
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51 Figure 10 Fricker, B. Long-term improvement profile from a survey conducted in 1997. In this case,
52 the evolution of effectiveness was illustrated with a linear regression line (dashed line).
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Figure 1

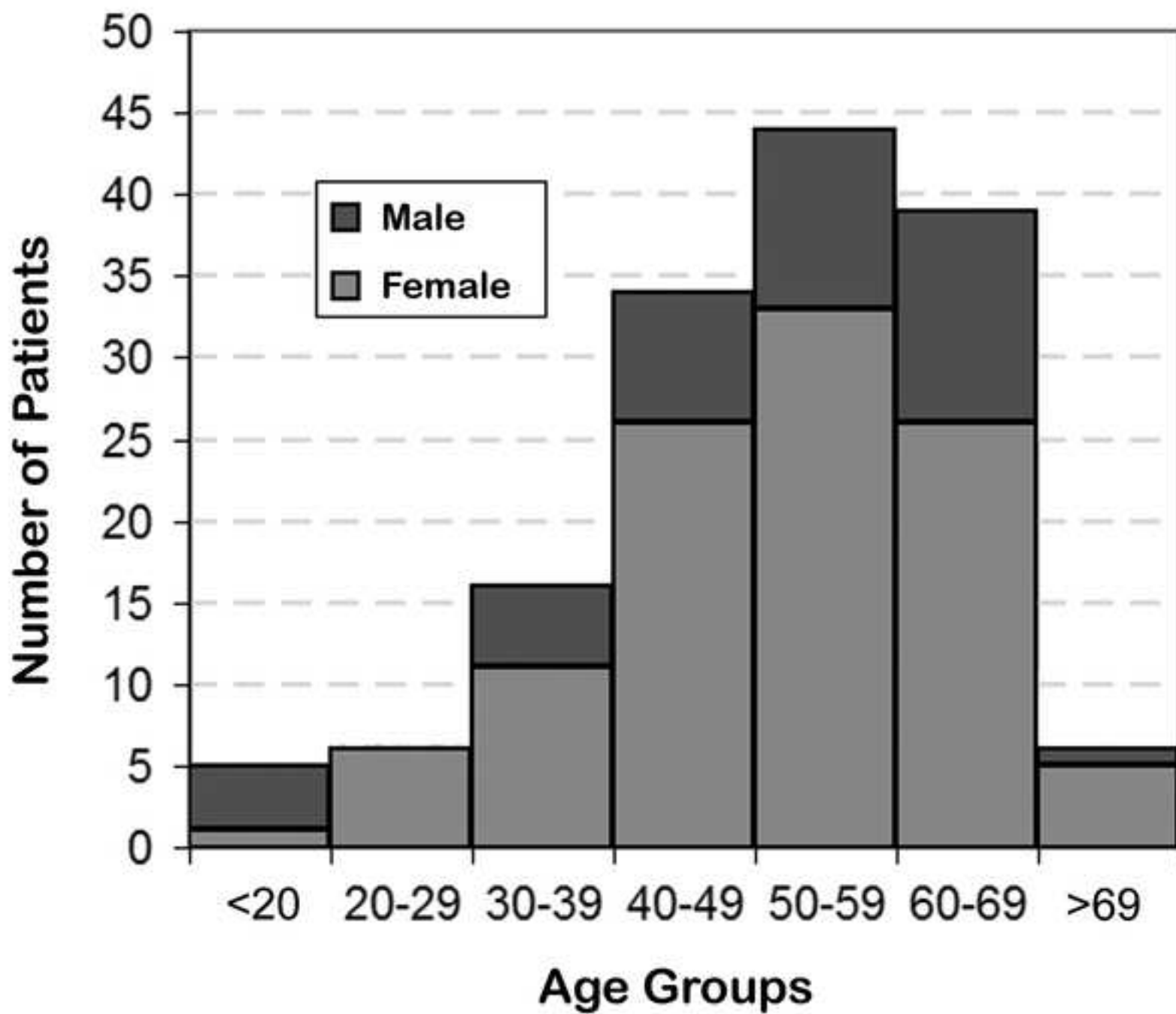


Figure 2

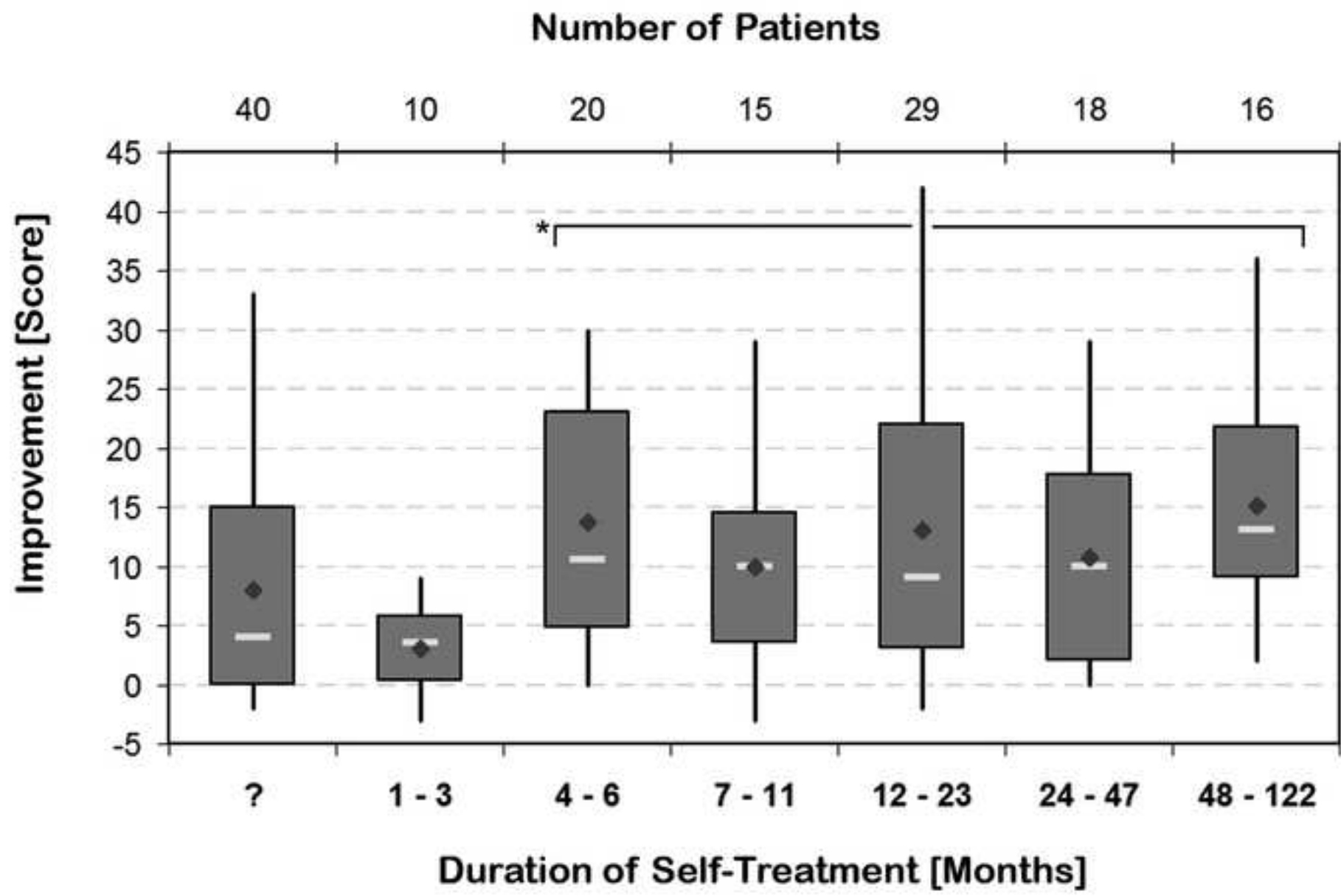


Figure 3

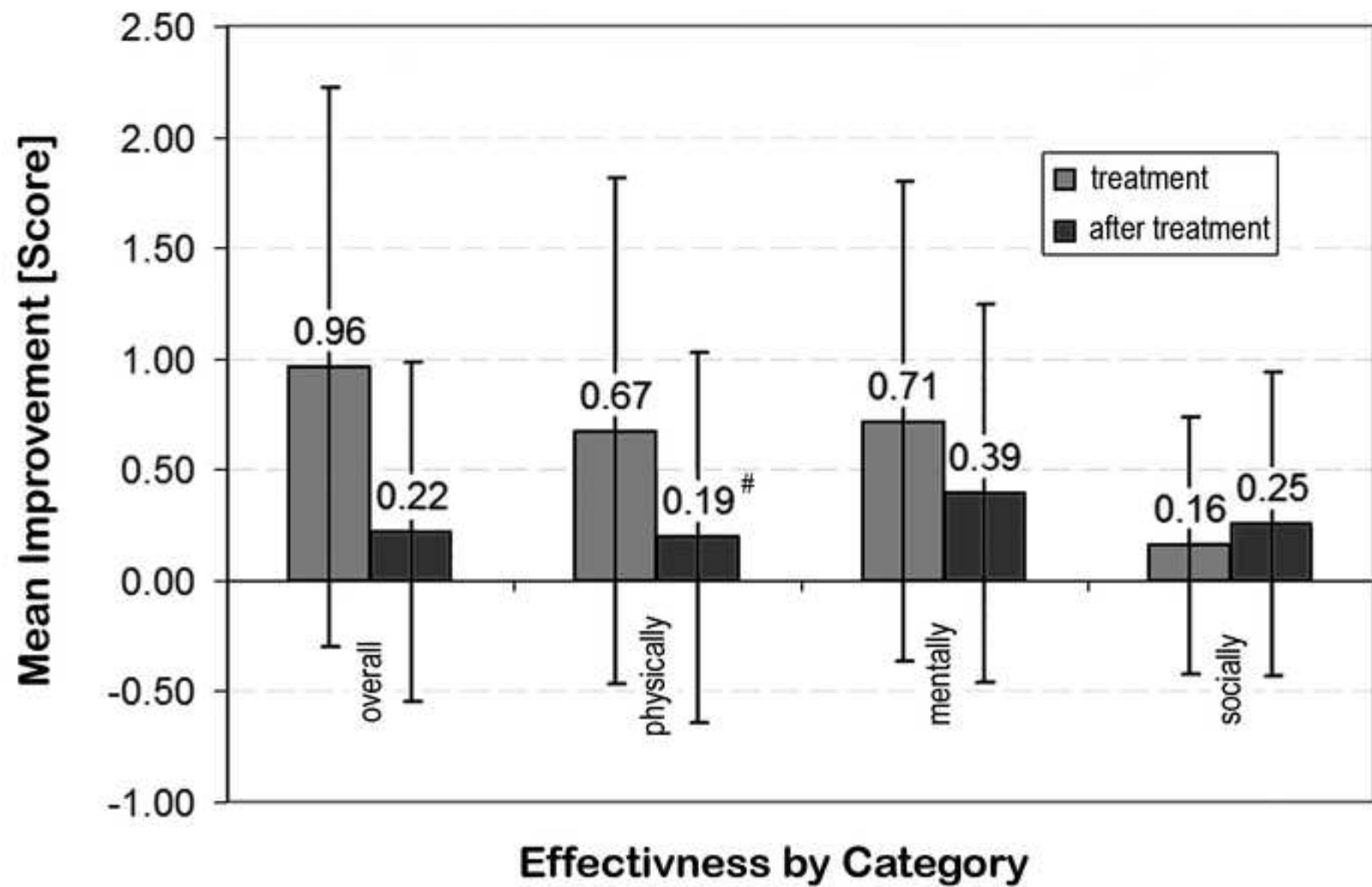


Figure 4

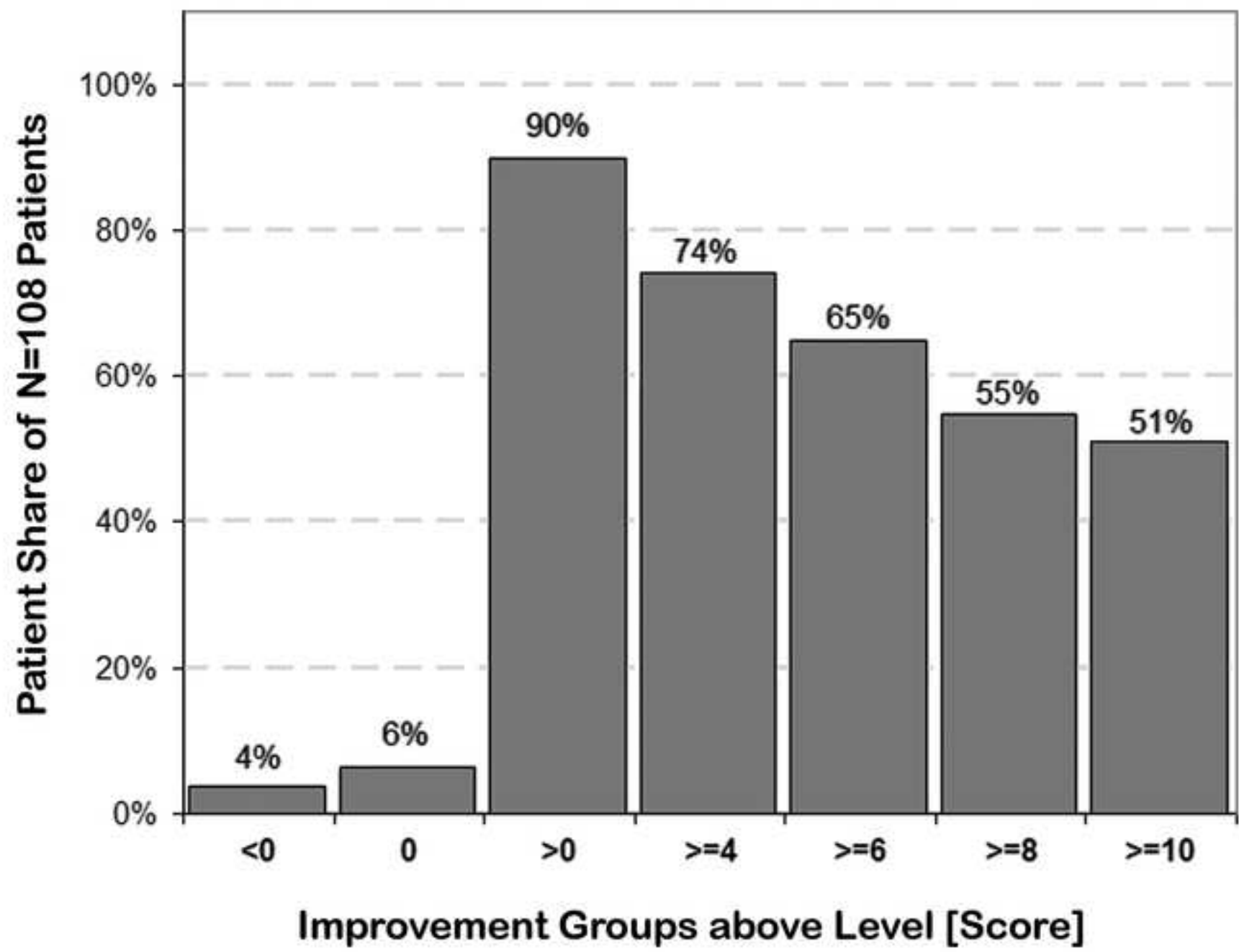


Figure 5

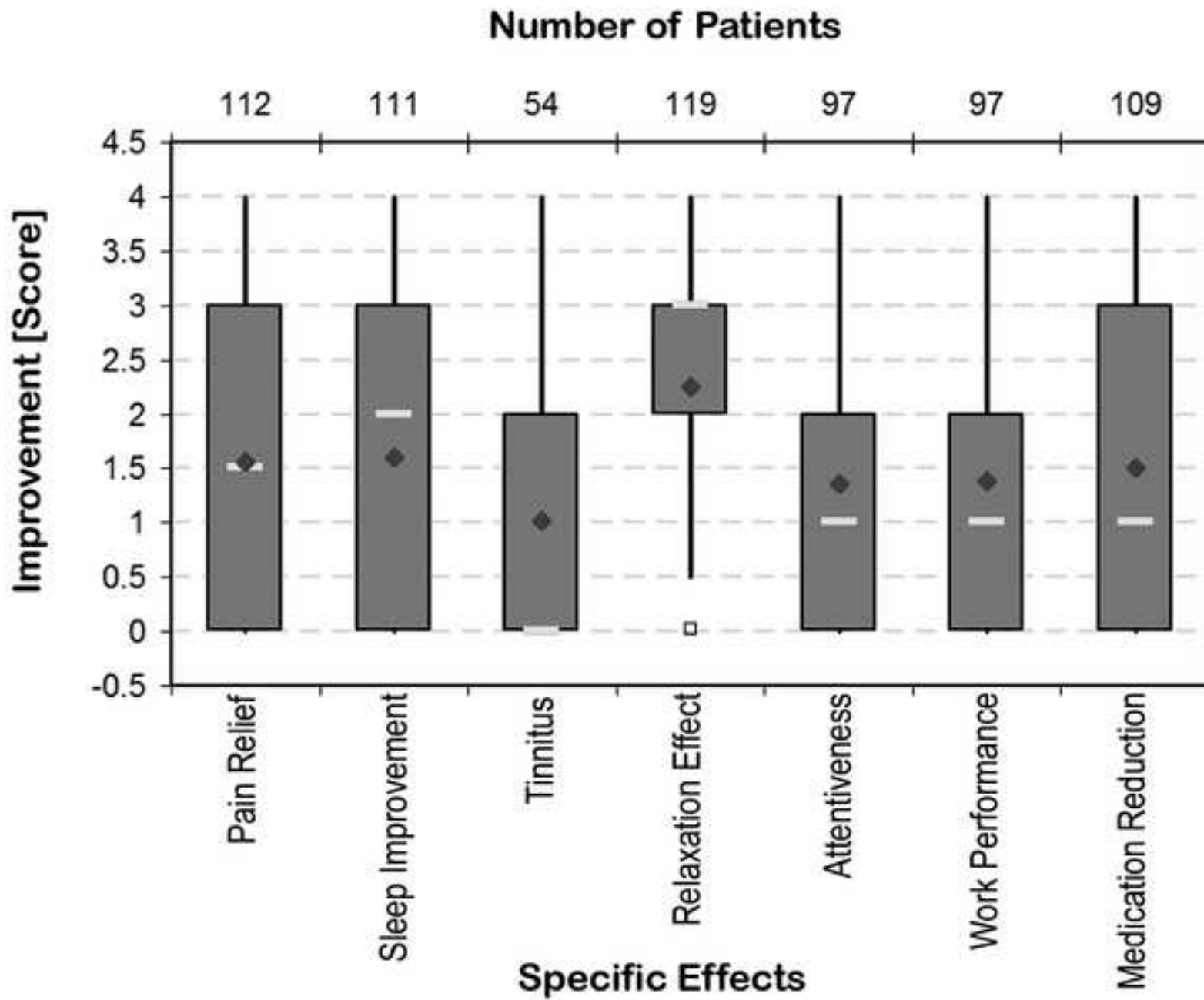


Figure 6

Summed Improvement Scores

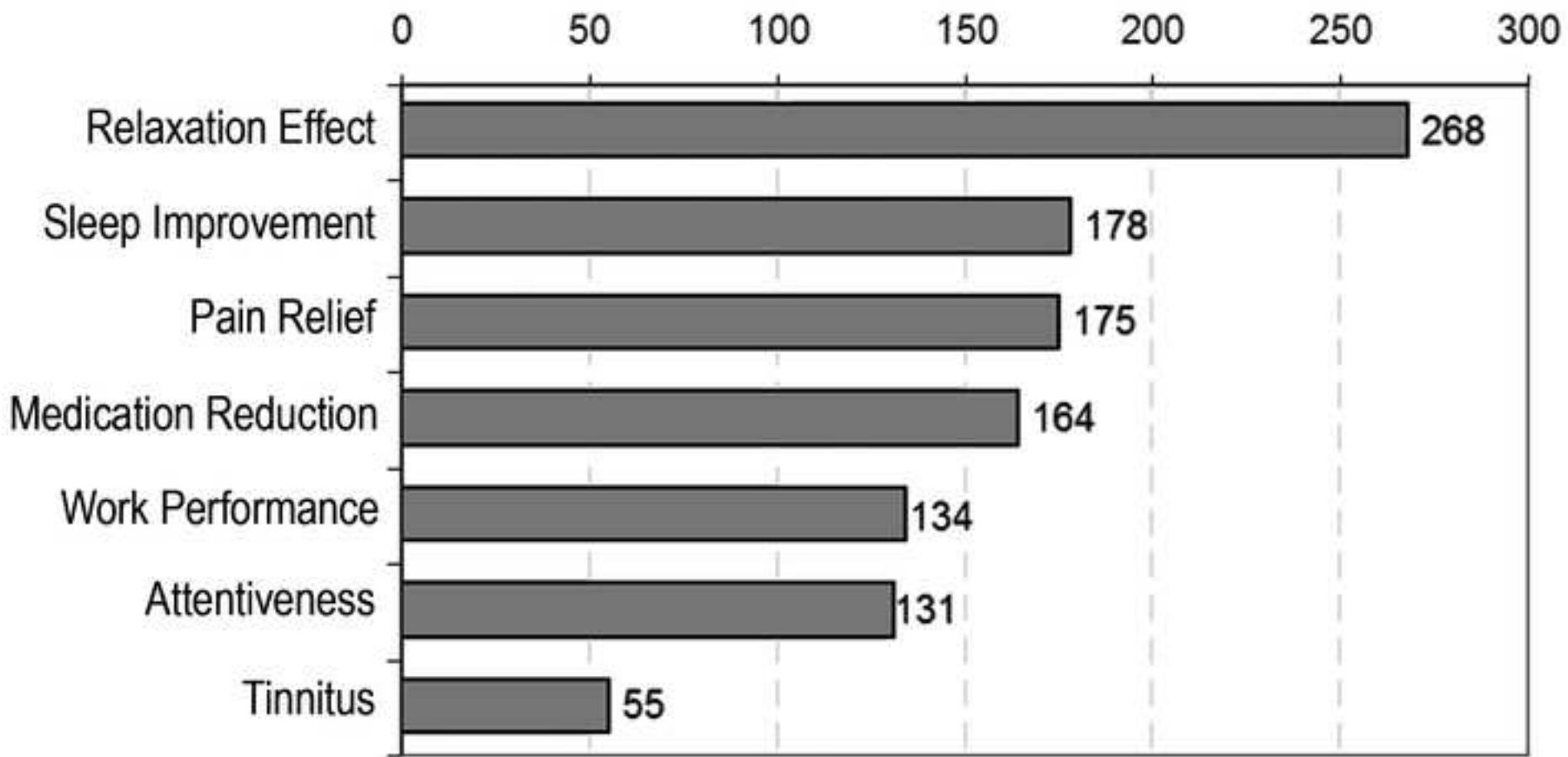


Figure 7

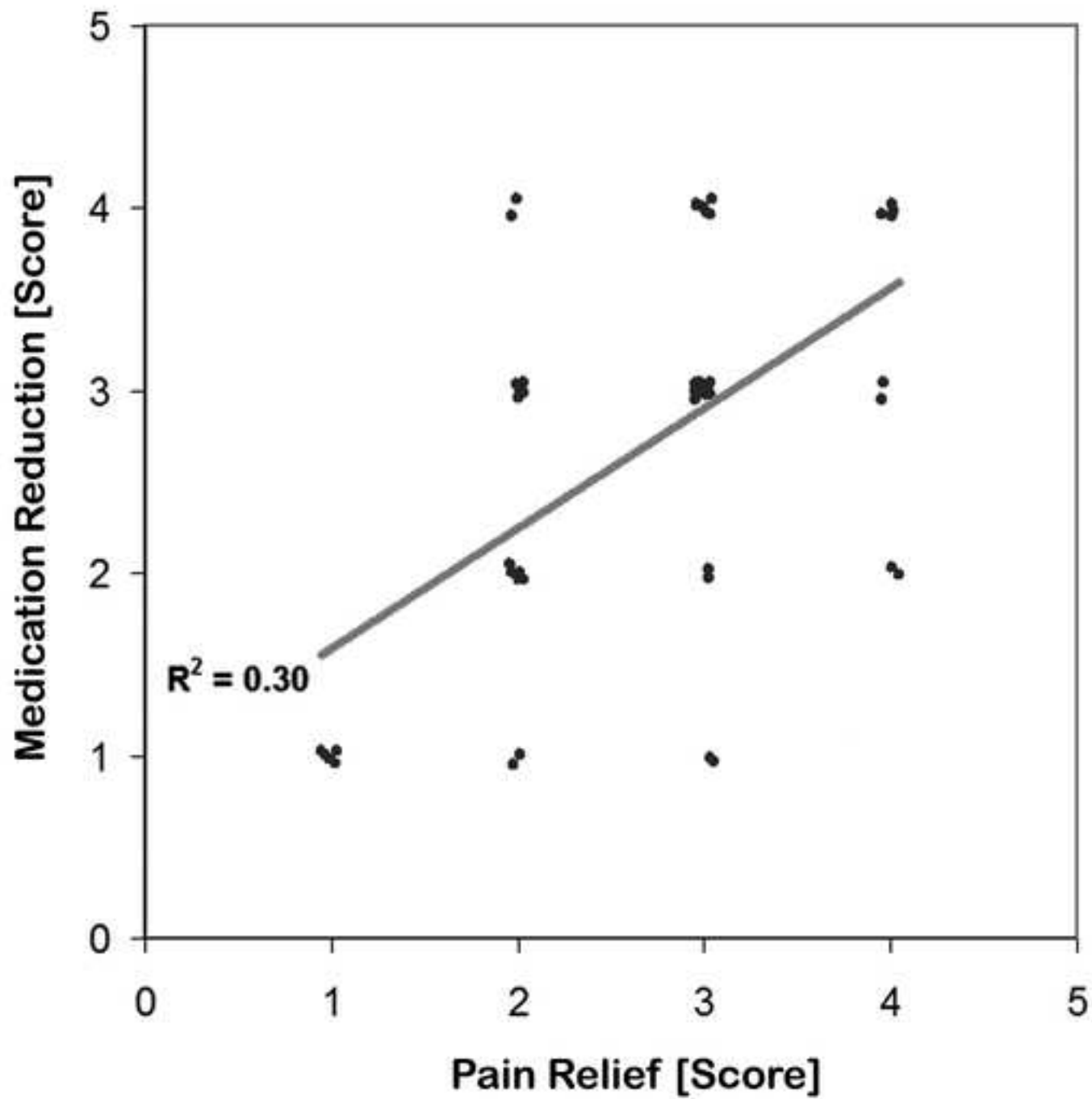


Figure 8

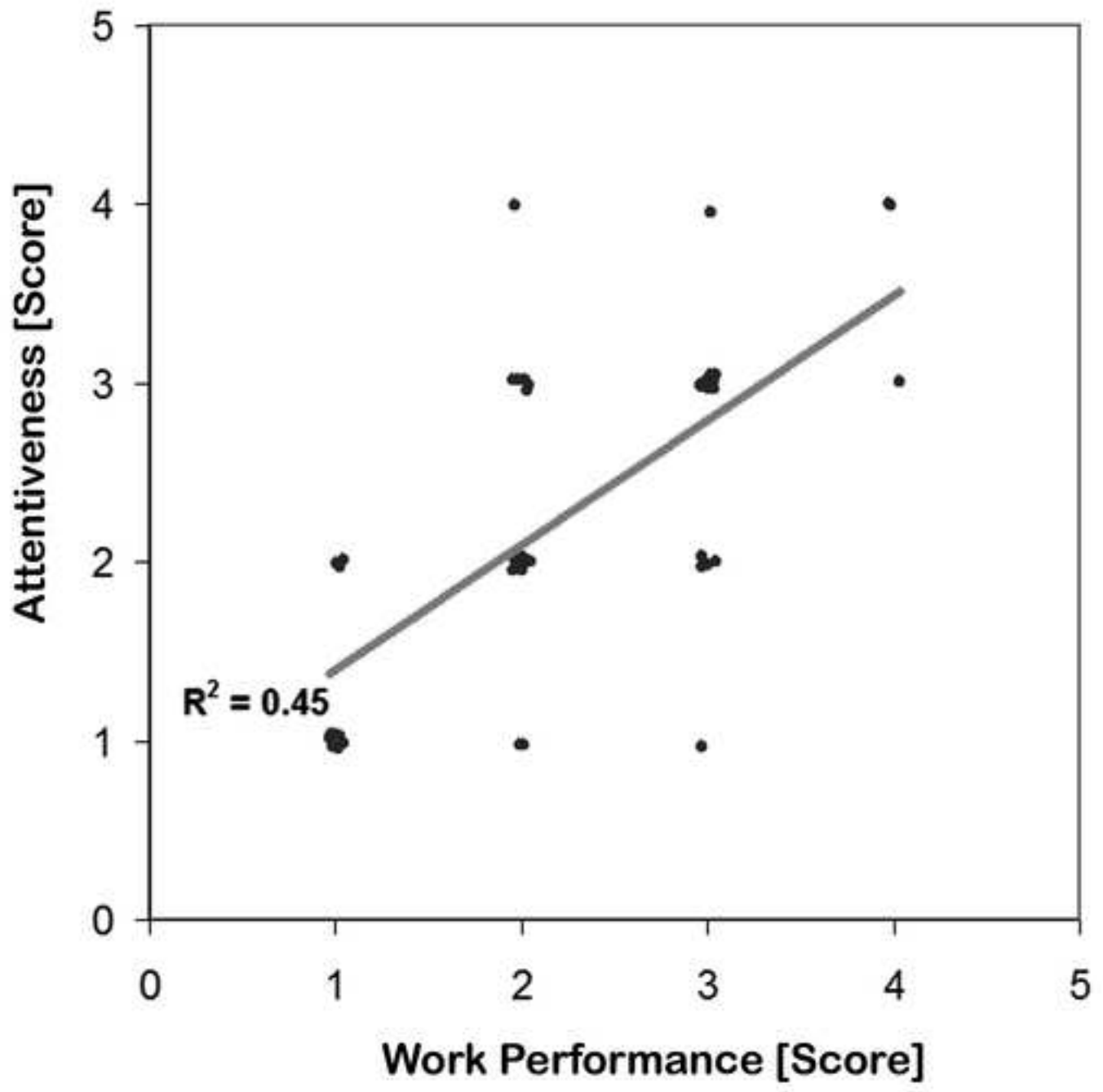


Figure 9

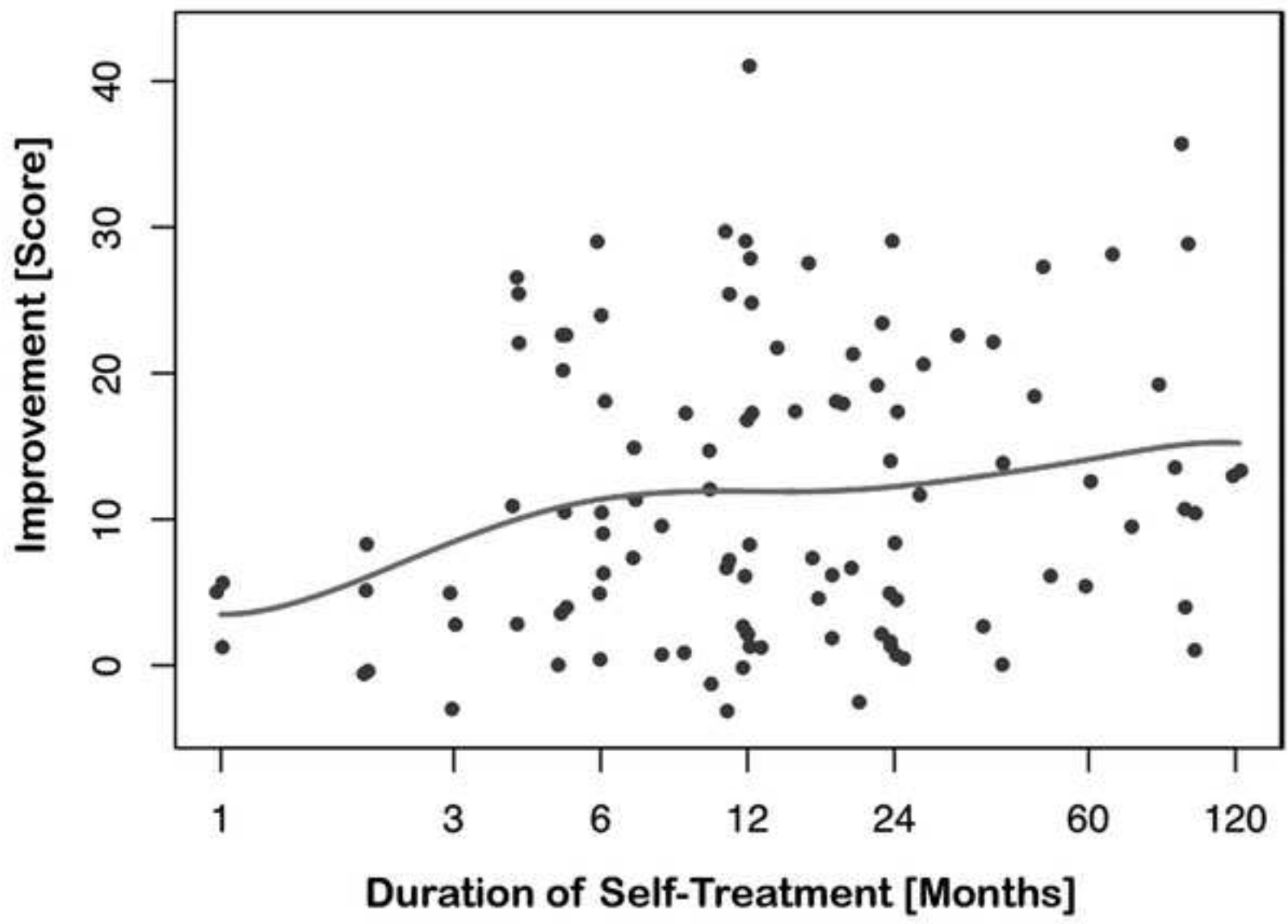


Figure 10

